

TAKING ACTION FOR TOMORROW

Bay Area Life Sciences
Strategic Action Plan



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OFFICE OF THE GOVERNOR

California has always been a center of innovation. It must—and it will—continue to be so. An entrepreneurial culture, diversity, and available talent are our heritage and our future. All major Life Sciences-related industries were born in California. The success of companies in the Bay Area, San Diego, and the greater Los Angeles basin is clear evidence that California is still the world leader in Life Sciences.

Our state is currently home to more than 2,500 biomedical companies, which employ 225,000 people in the areas of medical devices, biopharmaceuticals, academic research, wholesale trade, and lab services. These companies, in partnership with California's research universities, are developing and commercializing technologies that seek to conquer such crippling and deadly diseases as Parkinson's, Alzheimer's, and HIV.

Our continued success cannot be taken for granted. Our companies and their highly-skilled employees are being actively recruited by other regions in the U.S. and across the globe that seek to become leaders in biotechnology and other Life Sciences fields.

To meet this challenge, I have initiated efforts in the Bay Area, San Diego, the greater Los Angeles basin, and the Central Valley to bring together Life Sciences executives, research leaders, and government decision makers to share views, discuss challenges and opportunities, and make recommendations to improve the competitive environment.

This Strategic Action Plan is the result of the first of these initiatives, which was conducted in the Bay Area. My office, the Bay Area Council, the California Technology, Trade and Commerce Agency, and the Bay Area Bioscience Center, with support from the Monitor Group working with Ernst & Young, have spent six months building a comprehensive strategy to make the Bay Area even more competitive in preserving, attracting, and developing Life Sciences companies. While this Strategic Action Plan was compiled with the full support of my office, I do not necessarily endorse all of the recommendations herein.

When it comes to creating jobs, promoting business, and making California prosperous, we simply cannot wait for national or international conditions to change. But we must take charge of our own future. The Life Sciences industry represents a large part of that future. Not only does it provide an engine for economic growth, it also holds the key to alleviating the suffering and improving the health and well being of literally every human being in the world. This is the reason that Life Sciences will continue to be a key focus of our economic growth strategy.

Sincerely,

GRAY DAVIS

Governor

GOVERNOR GRAY DAVIS

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As announced by Governor Gray Davis, this Bay Area Life Sciences Strategic Action Plan forms the foundation of an overarching initiative by the state to promote California and the Bay Area as a center of innovation in Life Sciences. It describes the current context and frames the future vision for Life Sciences in the Bay Area. It also identifies critical priorities and sets forth recommended actions for fostering growth of Life Sciences in the region.

This Strategic Action Plan is a blueprint for government, universities, research institutions, companies, and economic development organizations to refocus cooperative actions that will have a positive impact on Life Sciences in the Bay Area, thereby strengthening the economy and enhancing the quality of life in the region and throughout California. It is intended to inform and educate policy makers and civic leaders about the importance of the Life Sciences industry cluster to the regional economy and to strengthen collaboration among stakeholders to enhance the competitiveness of Life Sciences in the Bay Area.

This Strategic Action Plan delineates a comprehensive set of recommendations, including, for example: mobilizing industry leadership and academic support for a strong and robust regional Life Sciences non-government organization; enacting flexible tax credits; and supporting current initiatives underway by the Bay Area Council and other employer-sponsored organizations to increase the supply of affordable workforce housing as well as to improve transportation mobility and relieve congestion.

This Strategic Action Plan is the result of a groundbreaking joint effort by organizations and individuals who have devoted significant time, energy and resources. The planning effort was formally launched at the Bay Area Life Sciences Summit in December 2002 at SRI International and has involved in-depth research, analysis and follow up since then. We are especially grateful for the dedication and hard work of the Office of the Governor of California, the California Technology, Trade and Commerce Agency, and the Bay Area Bioscience Center, supported pro bono by the full-time team from the Monitor Group. Ernst & Young, L.L.P. and California Healthcare Institute also have been of great assistance on particular components of the Strategic Action Plan. In addition, we greatly appreciate the Summit co-sponsors: Squire, Sanders & Dempsey, L.L.P., GrayCary, Marsh Risk and Insurance Services, and Rigel Pharmaceuticals, Inc. And, finally, I would like to thank the staffs of the Bay Area Council, Bay Area Economic Forum, and the Bay Area Science Infrastructure Consortium (BASIC). Together, they have developed a pragmatic plan of action that will support and advance Life Sciences in the Bay Area.

A handwritten signature in black ink that reads "Sunne Wright McPeak".

Sunne Wright McPeak
President & CEO
Bay Area Council



The Bay Area Bioscience Center (BayBio) commends the Governor, the California Technology, Trade and Commerce Agency, and the Bay Area Council for the completion of this important Bay Area Life Sciences Strategic Action Plan. BayBio wishes to thank all the participants in this comprehensive regional effort: the bioscience company executives, the regional Life Sciences service industry experts, academic and private sector research and education leaders, and local governments.

The Bay Area is home to the world's oldest and largest bioscience cluster. Understanding the unique culture and needs of a fully mature Life Sciences cluster proved to be a special challenge and this Strategic Action Plan is an excellent first step. To retain its relevancy, our Strategic Action Plan must remain a work-in-progress because of the rapid changes expected in the bioscience research, development and manufacturing sectors. For example, in contrast to five years ago when research was the primary regional activity, there are now a number of Bay Area companies with products in clinical trials. These companies may already be deciding whether to build or contract out for manufacturing needs. State tax policy, the cost of doing business, the cost of housing, and the region's infrastructure (water, power, transit/roads, and quality of K-12 education) promise to weigh heavily in companies' decision-making on the prime location for their changing facilities needs and workforce.

Competition from other regions of California, other states, and other countries cannot be underestimated. Remaining the bioscience location of choice is up to us. A concerted regionwide effort is a must. Now with "Taking Action for Tomorrow: Bay Area Life Sciences Strategic Action Plan" in hand, regional leaders, state government, and the bioscience community can join together to implement the Strategic Action Plan's recommendations. BayBio and its Board of Directors stand ready to take a leadership role in this important initiative.

Sincerely,

A handwritten signature in black ink, reading "Sue M. Day".

Sue Markland Day
President, BayBio

A handwritten signature in black ink, reading "Michael Arbige".

Michael Arbige
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ACKNOWLEDGEMENTS

The Bay Area Life Sciences Strategic Action Plan: Taking Action for Tomorrow is a joint effort of the Office of the Governor of California, the Bay Area Council, the California Technology, Trade and Commerce Agency (CTTCA), and the Bay Area Bioscience Center, with full-time support from the Monitor Group.

The Governor's team, led by Special Assistant Chris Campaña, brought together industry leaders and partners to coordinate their participation in the research, analysis and development of the plan. San Francisco Regional Office staff Robert Oakes, Gisela Hernández and intern Bahija Hamraz assisted in coordinating the Bay Area Life Sciences Summit in December 2002. The first phase of the project began in 2001, when CTTCA's Joe Raguso, and his team of analysts, Bonnie Cornwall, Greg Pochy and intern Sabrina Birnbaum, initiated the data collection and market analysis to establish the Plan's conceptual framework.

The Bay Area Council team included Sunne Wright McPeak, Kimberly Robinson, Thomas Kelley, Alana O'Brien, John Grubb, and Sally DiDomenico from the Bay Area Economic Forum and the Bay Area Science and Innovation Consortium (BASIC). The Bay Area Council, a regional business-sponsored public policy organization, partnered with the Governor's Office, the CTTCA, Bay Area Bioscience Center, and the Monitor Group to organize the Bay Area Life Sciences Summit, engage industry leaders, and prepare the Strategic Action Plan.

From the Bay Area Bioscience Center, Sue Markland Day and Caitlyn Waller provided insights and assistance throughout the development of the Strategic Action Plan.

A Monitor team led by Matthew Le Merle and Nancy Michels conducted the research and analysis, coordinated the interviews, and captured the ideas and recommendations presented in this Strategic Action Plan. Mr. Le Merle and Ms. Michels are Partners in the firm's San Francisco office. Monitor consultants Jennifer Cohen, Matthew Findley, Marielena Gutiérrez, Michael Held, and Alexis Wise worked actively on this project in the Bay Area. Pedro Arboleda, Jeff Grogan, and Kurt Dassel of the Monitor Group provided insights from their experiences and expertise in national, regional and cluster competitiveness efforts.

Lily Rappoli and the Design Studio at the Monitor Group illustrated, designed, and created the layout of this report.

In addition, Scott Morrison, Greg Jensen, and a team from Ernst & Young conducted the work that comprises the Capital Structure and Resources section of the Strategic Action Plan.

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Over 100 business and government leaders contributed to this Strategic Action Plan in some way by participating in interviews, completing surveys, attending the Bay Area Life Sciences Summit, and offering their views and expertise. This Strategic Action Plan benefits from their key insights on the region, on Life Sciences, and on drafts of this work.

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EXECUTIVE SUMMARY

The Bay Area¹ has held a leading position in global Life Sciences for more than 25 years. This sustained pattern of success rests on a number of factors—among them, leading research institutions, an innovative workforce, and a willing and cooperative venture capital community. Not surprisingly, it has also made the Life Sciences an increasingly important part of the Bay Area’s regional economy: today, some 726 companies employ nearly 80,000 in the Bay Area.²

Perhaps more important are the prospects for the future. Companies in the Life Sciences are quickly moving through their life cycles from development to commercialization and are bringing ever more products to market. This, in turn, will drive significant growth for Bay Area companies—and for the regional economy—during the next ten years. The Bay Area landscape will likely shift from a large number of small Life Sciences companies to a more limited population of large Life Sciences companies and new subsidiaries of large pharmaceutical companies. Indeed, over time, research and development (R&D) productivity of smaller Life Sciences companies will drive increased convergence of the pharmaceutical and biotechnology industries. The situation is clear: pharmaceutical companies need viable drugs to fill their pipelines, and biotechnology companies need funds to finance continued R&D.

In addition to that convergence, whole new segments of Life Sciences activity are already beginning to appear, as breakthroughs occur and as new technologies emerge from the convergence of the Life Sciences with areas such as Information Technology and nanotechnology.

The attractiveness of the Life Sciences is now well understood around the world. Competitive clusters are rapidly developing in other parts of the country and the globe. These newer clusters of innovation are being nurtured by increased planning and investment on the part of local, regional, and national governments. The inevitable result: a steadily more competitive environment in which the Bay Area Life Sciences will need to work hard to maintain its leading position.

What is new here is the growing recognition that the Bay Area’s strengths in the Life Sciences, though substantial, offer no reason for complacency. Competitive pressures will inevitably rise. The effort needed to sustain a leadership position will inevitably grow. The complexity of the task—the need for vision and efficient coordination, the integrated, systemic nature of the challenge, and the demands on scarce resources—will only expand. What will shrink is the margin for error, the “forgiveness” accorded to managerial and policy choices that are delayed, avoided, or off target.

Problems can no longer be allowed to fester silently or dissatisfaction to mount. They must be addressed and be seen to be addressed—openly, honestly, and aggressively. Otherwise, the most precious assets on which the cluster’s future health depends will slip away to more favorable environments.

Again, the current strength of Life Sciences in the Bay Area is real, not illusory. But it is fragile. It cannot be maintained by hope and goodwill alone, nor protected by denials that problems exist. While there is time—and, happily, there is time—responsible leaders must act. There is much to act on.

As the Life Sciences mature, for example, companies will face a host of capital-related challenges related to manufacturing and productivity, increased competition, and closer scrutiny by regulators. At the

same time, as the industry expands into new technologies, the same companies will need fresh capital to fund early-stage development. Here, too, there are questions: despite the significant role venture capital (VC) has played in the start-up of Life Sciences companies, traditional venture capital models are not in complete alignment with the Life Sciences product development process. The existing model fosters reluctance to invest in a company without a clear, near-term exit strategy. This puts pressure on Life Sciences companies to pursue quick discoveries rather than invest in high-potential, but long-term discoveries.

In addition, young companies in the Bay Area often find it difficult to find small, affordable wetlab space for short periods of time. The problem is especially acute now in the light of the tight venture capital market. For these companies, inconsistent and uncoordinated zoning and permitting practices are also troublesome. For such companies, as well as for larger and more established companies, the high property values around the Bay Area, the high cost of labor, the lack of tax incentives, the challenges of water supply, and other deterrents threaten to drive manufacturing activity to other regions.

In addition, despite some strengths, the region's unpleasant and uneconomic transportation infrastructure ranks as one of its greatest competitive weaknesses. Regions within the Bay Area regularly emerge at the top of lists of the nation's most congested areas. Recently, however, there have been some improvements in congestion levels.

In general, the emerging pattern of growth in the Life Sciences suggests that new employment will likely consist of R&D (50%), manufacturing (25%) and commercial, marketing, management and support (25%) positions.³ Given the importance of the Life Sciences to the economy of the Bay Area, it is critical for the supply of skilled labor to meet the cluster's burgeoning needs. Considering the long lead times inherent in changing and improving a region's human capital equation, there are reasons to fear that the requirements of growth will outstrip the available human assets.

It is within this dual context of current strength but perceived fragility and of increasing statewide, nationwide, and global competition for Life Sciences development that Bay Area companies, governments, universities, and research institutions must take action to ensure a healthy cluster for the future. Toward that end, the Office of the Governor of California, the Bay Area Council, the California Technology, Trade and Commerce Agency, and the Bay Area Bioscience Center, with support from the Monitor Group, undertook an effort, summarized in this document:

To develop a coordinated and actionable Strategic Action Plan to ensure that the Bay Area continues to grow and sustain its leadership in Life Sciences over the next decade.

At the Bay Area Life Sciences Summit held on December 2002, throughout the interviews and surveys conducted by the Monitor Group, and in the many working sessions of the multiple parties contributing to this Strategic Action Plan, a set of common themes emerged: a shared industry plan is needed; distinctive Bay Area strengths must be actively preserved; and several critical weaknesses need to be addressed (Appendix A provides a detailed discussion of the strategic planning process).

As a result of this planning process, a full list of recommendations, summarized in Exhibit 13, has been developed and is discussed in detail in Chapters 4-12 of this Strategic Action Plan. Of these, the 15 top priority recommendations, to begin now, are:

Recommendations for Short-Term Improvements

- ♦ Mobilize industry and academic support behind a strong and active Bay Area Life Sciences non-governmental organization to optimize the Life Sciences growth potential in the region. (Chapters 7, 12)
- ♦ Mobilize political jurisdictions behind marketing the Bay Area as the best region in the world for the Life Sciences. (Chapter 12)
- ♦ Protect and increase investments in the Bay Area Life Sciences intellectual infrastructure, including completion of the California Institute for Quantitative and Biomedical Research (QB3) and the Life Sciences research park at NASA Ames. (Chapter 10)
- ♦ Create a better statewide business climate for Life Sciences firms by allowing large Life Sciences companies, either headquartered in California or employing a significant number of Californians, to purchase discounted tax credits / deductions from small research and development firms and, thus, provide those firms with much needed cash. (Chapter 4)
- ♦ Establish and communicate current and future employment needs by skill category in order to drive Bay Area educational and training activity. (Chapter 7)
- ♦ Make the current University of California technology licensing processes more transparent and accessible, while gaining a better direct understanding of industry needs. (Chapter 9)
- ♦ Encourage public (state, local, and university) retirement system / investment fund managers to consider additional or first time investment in the California Life Sciences. (Chapter 4)

Recommendations for Longer-Term Improvements

- ♦ Direct the California Technology, Trade and Commerce Agency (CTTCA) in collaboration with other regional leadership groups to work closely with the University of California Office of the President and Technology Licensing Offices of each University of California campus to develop strategies to accelerate the transfer of technology. (Chapter 9)
- ♦ Ensure public education officials place greater focus on science education in the public schools, and have state community colleges and universities develop more clinical science and laboratory programs in collaboration with industry. (Chapter 7)
- ♦ Encourage state and industry representatives to explore alternative financing structures for the Life Sciences industry. (Chapter 4)
- ♦ Ensure collaboration between industry representatives and local, regional, and state government officials to identify the future manufacturing and distribution needs of the industry and determine where the Bay Area should focus. (Chapter 5)
- ♦ Facilitate the development of commercial space for start-up and young Life Sciences companies by encouraging creative public-private partnerships. (Chapter 5)
- ♦ Support initiatives to improve public transportation and relieve traffic congestion. (Chapter 6)
- ♦ Introduce incentives to increase the supply of affordable housing. (Chapter 5)
- ♦ Improve the overall K-12 public school system by continuing to support state and regional initiatives. (Chapter 11)

As Governor Gray Davis noted in his introductory letter, “When it comes to creating jobs, promoting business, and making California prosperous, we simply cannot wait for national or international conditions to change. But we must take charge of our own future. The Life Sciences industry represents a large part of that future. Not only does it provide an engine for economic growth, it also holds the key to alleviating the suffering and improving the health and well being of literally every human being in the world. This is the reason that Life Sciences will continue to be a key focus of our economic growth strategy.”

RECOMMENDATIONS AND ROLES BY CONSTITUENCY

Cluster Impact	Cluster Constituency	Decision Making	Lead Agency	Partners
Capital Structure and Resources	Create a better statewide business climate for Life Sciences firms by allowing large Life Sciences companies, either headquartered in California or employing a significant number of Californians, to purchase discount tax credits/deductions from small R&D firms and, thus, provide those firms with cash.	X		X
	Encourage public (state, local, and university) retirement system/investment fund managers to consider additional or first time investments in the California Life Sciences.	X		
	Encourage state to explore alternative financing structures for the Life Sciences.	X		X
	Ensure the state of California's ability to attract and retain Life Sciences companies of all sizes through tax incentives.	X		
	Provide creative incentives and sources for financing of Life Sciences.	X		
	Facilitate alliances between Pharmaceutical (mature) and Biotechnology/Emerging Technology (early-stage/R&D) firms.	X		
Commercial and Residential Infrastructure	Ensure collaboration between industry representatives and local government officials to identify the future manufacturing and distribution needs of the industry and determine where the Bay Area should focus.	X		X
	Facilitate the development of commercial space for start-up and young Life Sciences companies by encouraging creative public-private partnerships.	X		X
	Introduce incentives to increase the supply of affordable housing.	X		
	Create a Life Sciences infrastructure best practices guide.	X		
	Increase public acceptance of affordable housing.	X		
	Influence decision makers to make "Smart Growth" residential planning choices.	X		X
	Revitalize underused and deteriorated urban areas.	X		
Transportation and Information Infrastructure	Support initiatives to improve public transportation and relieve traffic congestion.	X		
	Expand deployment of Intelligent Transportation Systems (ITS).	X		
	Introduce market pricing mechanisms.	X		
	Study transit operator coordination and create an action plan.	X		
	Increase water transit on the San Francisco Bay.	X		
	Generate additional and stable transportation funding.	X	X	X
Human Capital	Establish and communicate current and future employment needs by skill category.	X	X	X
	Ensure state education officials place greater focus on science education throughout the public education system.	X	X	X
	Expand scope of universities to create a versatile future workforce.	X	X	
	Continue to recruit and retain world-class talent.	X		X
Entrepreneurial Climate	Design a centralized web-based resource database.			
	Leverage proximity to other high tech clusters in the Bay Area as a source for new ventures.	X	X	X
Technology Commercialization	Make the current University of California technology licensing processes more transparent and accessible, while gaining a better direct understanding of industry needs.		X	
	Direct the California Technology, Trade and Commerce Agency (CTTCA), in collaboration with other regional leadership groups, to work closely with the University of California Office of President and Technology Licensing Offices of each University of California campus to develop strategies to accelerate the transfer of technology.	X	X	
	Facilitate formal communication between Bay Area technology transfer offices.	X	X	
	Support timely licensing and collaboration deals.	X	X	
Intellectual Infrastructure	Protect and increase investments in the Bay Area Life Sciences intellectual infrastructure, including completion of the California Institute for Quantitative and Biomedical Research (QB3) and the Life Sciences research park at NASA Ames.	X	X	
	Foster laboratory capital development.	X	X	
	Strengthen corporate/university relationships and networks.		X	X
	Utilize adjunct professorships and sponsored forums to enhance communication.		X	X
	Simplify mechanisms for cross-university course registration.		X	
Quality of Life	Improve the overall K-12 public school system by continuing to support state and regional initiatives.	X		
	Ensure teachers' pay is in line with the rising cost of living.	X		
A Cluster Voice	Mobilize industry and academic support behind a strong and active regional Life Sciences non-governmental organization to optimize Life Sciences growth potential in the region.	X	X	X
	Mobilize political jurisdiction behind marketing the Bay Area as the best region in the world for the Life Sciences.	X	X	

INTRODUCTION: A LIFE SCIENCES STRATEGIC ACTION PLAN

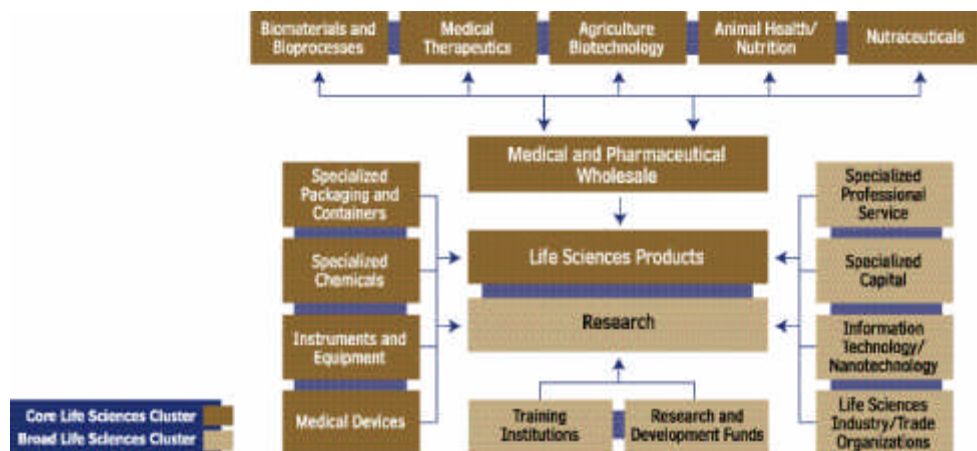
This chapter lays out a working definition of the Life Sciences cluster, briefly outlines the historical drivers of this success in the Bay Area, and profiles its continuing importance to the Bay Area and to the state of California.

THE LIFE SCIENCES CLUSTER

A cluster, as defined by Harvard University Professor and Monitor Group Partner and Co-Founder Michael Porter, is “a geographically proximate group of interconnected companies and associated institutions in a particular field, linked by customer, supplier, or other relationships.” This definition cuts across traditional industry classifications and recognizes the importance of cross-industry linkages to an innovative and competitive environment.

Considered as a cluster, Life Sciences recognizes and affirms the relationship among closely related “core” industry segments (such as pharmaceuticals, medical devices, and agricultural biotechnology). But it also includes those additional industries—among them specialized professional service firms (law firms, real estate developers), specialized capital providers (biotechnology venture capital), research institutions, and industry associations—that regularly interact with core organizations. Further, it acknowledges connections with related industries and disciplines, such as Information Technology and nanotechnology, that are expected to further converge with Life Sciences.

Exhibit 1: Life Sciences Cluster Definition



The theory underlying this notion of a “cluster of innovation” derives from an examination of the critical factors necessary for fostering innovation, competition, and growth in a wide variety of regions and industries. It provides the framework for analysis in this Strategic Action Plan. The theory is described more fully in Appendix C. For the Life Sciences cluster in the Bay Area, there are eight critical factor conditions: Capital Structure and Resources, Commercial and Residential Infrastructure, Transportation and Information Infrastructure, Human Capital, Entrepreneurial Climate, Technology Commercialization, Intellectual Infrastructure, and Quality of Life. Each receives close attention in a later chapter of this Strategic Action Plan (Chapters 4 – 11).

HISTORICAL ROOTS

Following the pioneering work of Syntex Corporation (founded in Palo Alto in 1961, now Roche Bioscience) and Cetus Corporation (founded in Berkeley in 1971), a university researcher and a venture capitalist formed Genentech, the world’s first biotechnology company, in 1976. The first major breakthrough that led to its formation came in 1973 when Stanford geneticists Stanley Cohen and Annie Chang, along with University of California San Francisco biochemists Herbert Boyer and Robert Helling, developed a process to construct a DNA molecule containing the genetic materials from two different species. This was the start of recombinant DNA technology. The combination of entrepreneurship and scientific innovation in the Bay Area has continued to this day, forming the nucleus of its flourishing Life Sciences cluster.

As Eric Niiler aptly wrote in “Biotechnology in the Bay”:

The golden-brown hills that surround the Bay Area of San Francisco, California, are biotechnology’s equivalent of Olduvai Gorge—the cradle of humankind. It’s the place where entrepreneurial scientists took their first steps in founding a life science industry that now stretches the world over, with product sales in the multi-billion dollar range.

LIFE SCIENCES IN CALIFORNIA

California has four significant Life Sciences clusters, the Bay Area, San Diego, the greater Los Angeles basin, and the Central Valley. Not surprisingly, these California-based clusters play a substantial role in the overall U.S. Life Sciences industry. Almost 90% of California’s Life Sciences industries are concentrated in these first three regions, with the Bay Area having the largest and most diverse Life Sciences cluster. This diversity includes activity in virtually all product types and all stages of the value chain, from early research to manufacturing, sales and marketing (Exhibit 2).

Exhibit 2: Ranking Life Sciences Cluster by Employment

Pharmaceuticals Manufacturing	Instruments Manufacturing	Medical Devices Manufacturing	Research
1. Philadelphia	1. Bay Area	1. Minneapolis-St. Paul	1. Bay Area
2. Los Angeles	2. Boston	2. Bay Area	2. Houston
3. Newark, NJ	3. Bridgeport	3. Los Angeles	3. Boston
4. Middlesex-Somerset-Henderson	4. Los Angeles	4. Boston	4. Washington DC
5. Chicago	5. San Diego	5. Chicago	5. Los Angeles
6. Bay Area	6. Indianapolis	6. St. Louis	6. Cincinnati

Source: California Technology, Trade and Commerce Agency

THE IMPORTANCE OF LIFE SCIENCES TO THE BAY AREA

The Bay Area region, which covers 7,000 square miles of land around the San Francisco Bay, consists of nine counties: Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma. It is home to nearly 7 million people — roughly one-fifth of the state of California’s population — and includes the major cities of San Jose, San Francisco, and Oakland.⁴ The contribution of Life Sciences to the Bay Area’s well being can be measured along four important dimensions:

- Regional Economy
- Employment and Wages
- Research and Development
- Capital

Each is discussed in turn.

Regional Economy

The Bay Area plays a key role in the California economy. It produces more than \$335 billion in goods and services each year, representing one-third of the gross state product (GSP). The average output per employee in the region is \$110,400, which is 33% higher than the average state level of \$82,970.⁵

The Bay Area’s Life Sciences cluster contributes approximately \$12 billion to the regional economy, or 3.6% of the Bay Area’s gross metropolitan product (GMP). Further, labor productivity for the cluster is 32% higher than the average for all industries in the Bay Area. Exhibit 3 illustrates the contribution of Life Sciences in GMP and wages to each of the Bay Area counties.

Exhibit 3: Life Sciences in Bay Area Counties

County	Total GMP (\$Bn)	Life Sciences GMP (\$Bn)	Life Sciences % of total GMP	Average Life Sciences Wages (\$)	Degree that Exceeds Average County Wage* (%)
Alameda	55.4	2.9	5.2%	70,300	58%
Contra Costa	27.3	0.61	2.2%	61,000	42%
Marin	10.4	0.69	6.6%	64,300	49%
San Francisco	56.1	0.11	0.2%	80,800	38%
San Mateo	37.1	1.9	5.1%	114,300	65%
Santa Clara	130.3	4.5	3.5%	78,200	(2)%
Sonoma	10.6	1.0	9.4%	60,200	91%
Solano and Napa**	8.6	0.29	3.3%	54,500	49%
Total Bay Area	335.8	11.99	3.6	79,200	35%

Note: *Degree to which the average regional Life Sciences wage in a particular county exceeds average overall wage in that county.

**Data available combines Napa and Solano. However, it should be noted that most Life Sciences activities currently occur in Solano County.

Source: Milken Institute, Economy.com, 2001.

Employment and Wages

The Bay Area currently has a labor force of approximately 3.8 million people, of whom 80,000 are in the Life Sciences cluster.⁶

As a result of the high concentration of leading technology and financial services companies, wages in the Bay Area are among the highest in the nation. The average annual wage level for the region in 2000 was \$58,824, significantly higher than both the state average of \$41,182 and the national average of \$35,305.⁷

As illustrated in Exhibit 3, wages in the Life Sciences cluster are significantly higher than average wages in all but one of the Bay Area counties. Thus, the Life Sciences represent a high-wage enclave within one of the highest wage regions in the country. This underscores the importance of increasing the number of Life Sciences jobs in the Bay Area.

Research and Development

The Bay Area is home to numerous research universities and institutions, anchored by the three major research universities: Stanford University; University of California, Berkeley (UC Berkeley); and University of California, San Francisco (UCSF); and neighbor to University of California, Santa Cruz (UC Santa Cruz) and University of California, Davis (UC Davis). The universities in the region conduct more than \$1.4 billion in research annually, which comprises approximately one-third of all university research in the state. Sixty-two percent (approximately \$900 million) of the \$1.4 billion is in the area of Life Sciences. The Bay Area universities receive significant funding from the National Institute of Health (NIH)—\$803 million in NIH grants in 2001 alone. More than three-quarters of the region's NIH funding goes to UCSF (4th largest NIH grant recipient in U.S.), Stanford (9th largest), and UC Berkeley (51st largest).⁸

These universities, combined with a number of prominent private and federal research institutions, such as SRI International—a non-profit organization,—the National Aeronautics and Space Administration (NASA) Ames, Lawrence Livermore, and Lawrence Berkeley Laboratories in the Bay Area, provide the basis of intellectual capital for the Bay Area Life Sciences cluster. The high caliber research conducted in the region has resulted in a significant intellectual property development, with California accounting for 22% of all U.S. Life Sciences patents in 1999. The Bay Area received 1,345 of the 3,561 national patents awarded to California, which represented 38% of all Life Sciences patents in the state during 1999.⁹

Capital

California dominates the U.S. venture capital (VC) market. It is home to one-third of all deals and approximately 40% of all venture capital dollars invested in the U.S.. In 2001, the Bay Area accounted for 77% of all venture capital dollars invested and 72.5% of deals in the state. From 1995 to 2001, venture capital flows into the state grew faster than the national average. Bay Area investments jumped from \$2 billion to \$13 billion (570% increase).¹⁰ Of course 2002 and 2003 have seen a significant decline in new money flowing into the venture capital industry and into Life Sciences. This is as true of the Bay Area as of any part of the nation.

The Bay Area region received 31% of all venture capital investments in biopharmaceuticals between 1995-2001. It is very well represented with 21 highly active venture capital firms; the next highest concentration is 10 in the Boston cluster. Between 1998 and 2001, Bay Area biopharmaceutical companies

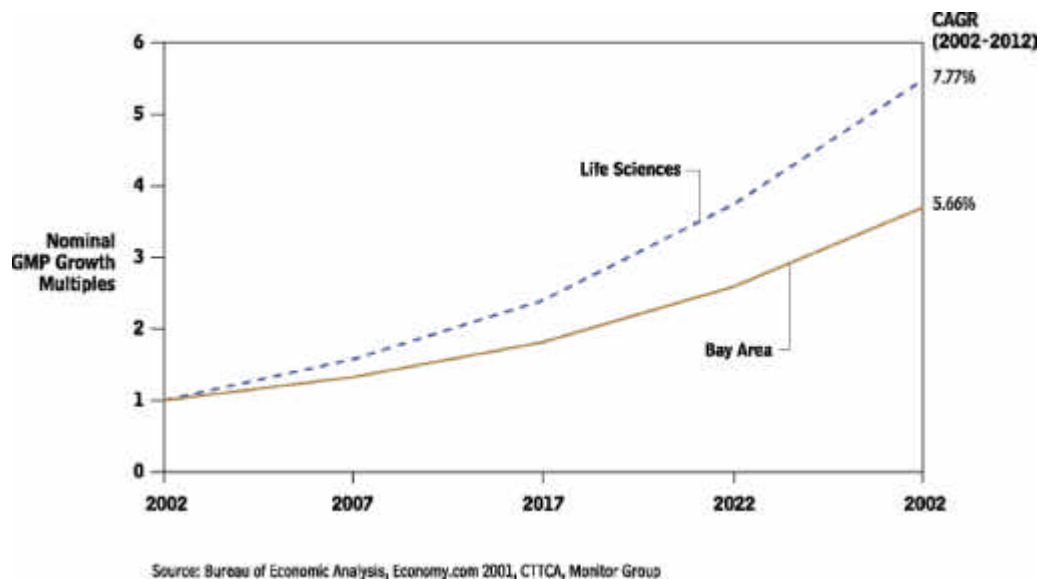
conducted 31 initial public offerings (IPOs), as compared to the next highest IPO levels of 10 and 8, respectively, for the San Diego and Seattle regions.¹¹

IMPLICATIONS FOR THE BAY AREA ECONOMY

The Life Sciences cluster has clearly established an important position in the Bay Area and in California. Along multiple dimensions, the cluster already provides a positive and differentiating contribution to that of the other lead clusters in the region. Even more important, it also provides the prospect of significant economic growth for the region.

Today, Life Sciences represents approximately 3.5% of the Bay Area GMP. Its relative contribution will likely increase two-fold over the next 10 years. As illustrated in Exhibit 4, the Life Sciences cluster is projected to grow more than 20% faster than the overall Bay Area economy.¹²

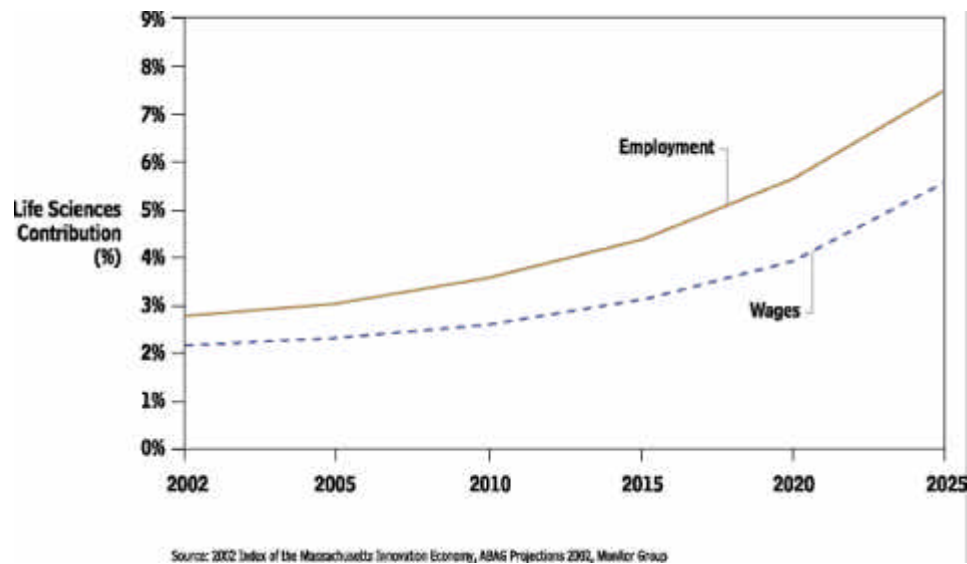
Exhibit 4: Nominal Life Sciences Cluster GMP Growth



As already noted, the cluster currently accounts for roughly 2% of the region's 3.8 million jobs.¹³ This will grow to 3% in 2010 (assuming increases consistent with those of the past ten years) (Exhibit 5).¹⁴ Furthermore, given the higher average wages of Life Sciences employees, the cluster represents approximately 2.8% of the region's aggregate wages.¹⁵ Coupled with the employment projections (assuming constant wages), this means the cluster will represent approximately 3.9% of the region's aggregate wages earned in 2010. Only \$1 out of every \$35 earned in the region today is associated with the Life Sciences industry. By 2005, the ratio will shift to \$1 out of every \$13, that is, if the region is able to support and nurture this growth.

These numbers do not, however, take into account the employment and earnings associated with Life Sciences-related legal, venture capital, and real estate companies. The multiplier effect that core Life Sciences segments will have on such related and supporting industries makes the further development of the cluster of prime importance to the state and the Bay Area economy.

Exhibit 5: Life Sciences Contribution to the Bay Area



LIFE SCIENCES AND HUMAN WELL-BEING

The Life Sciences cluster develops therapeutics that enable patients to live longer, healthier, and more productive lives. It invested more than \$30 billion in 2001 in discovering and developing new medicines.¹⁶ Life Sciences companies are leading the way in the search for new cures that address unmet global medical needs. In recent years, the industry has placed new therapies for leukemia, asthma, glaucoma, congestive heart failure, Alzheimer's, schizophrenia, HIV/AIDS, hepatitis, and many other diseases into the hands of doctors.¹⁷

Life Sciences tools and techniques open new research avenues for discovering how healthy bodies work and what goes wrong when problems arise. Life Sciences products include quicker and more accurate diagnostic tests, therapies with fewer side effects, and new and safer vaccines. For example, the wealth of genomics information made available by the Human Genome Project will greatly assist doctors in diagnosing hereditary diseases, many of which we cannot currently detect.¹⁸ However, realizing the potential in genomic information will require continued investment and dedication to the Life Sciences over the long term. Research conducted at Bay Area universities has the potential to produce therapeutic products for society that may benefit many millions of people. In addition to these improvements in human health, advances in the Life Sciences can improve human well-being in other ways, such as improving the environment and increasing agricultural productivity. Continued investment in the Life Sciences cluster will be critical to ensure that its beneficial products continue to reach a growing global population.

LOOKING FORWARD: KEY TRENDS AND CHALLENGES

2

During the next ten years, the Bay Area Life Sciences cluster will continue to be shaped by dynamic financial, scientific, and social influences. In many ways, it is still in its infancy. Results from the Human Genome Project are, for example, just beginning to bear fruit, and powerful new therapeutics are reaching the marketplace in greater numbers each year.

This chapter outlines the nine trends of greatest importance to the continued evolution of the Bay Area Life Sciences cluster during the next ten years. Exhibit 6 identifies these, as well as their major implications for the health and growth of the cluster:

Exhibit 6: Key Life Sciences Trends and Cluster Implications



Maturing Biotechnology Business Models

The traditional focus of biotechnology companies has been upstream research in the pharmaceutical value chain, leading to drug discovery platforms, subscription content databases, or early stage drug candidates. However, this is beginning to change in several ways.

First, an increasing number of products are moving through the pipeline toward regulatory approval and sale in the marketplace. As this “maturing” takes place, many developing biotechnology companies are shifting beyond their core research capabilities into downstream activities such as clinical development, manufacturing, and sales / marketing. However, many, if not most, companies will continue to out-license molecules to vertically-integrated pharmaceutical companies or become acquisition targets for companies looking to bolster their development pipelines. Indeed, over time, research and development (R&D) productivity of smaller Life Sciences companies will drive further convergence of the pharmaceutical and biotechnology industries. The situation is clear: pharmaceutical companies need viable new drugs to fill their pipelines, and biotechnology companies need funds to finance continued R&D.

Even so, biotechnology firms will choose to build in-house sales and marketing capabilities in order to receive a greater share of eventual commercial revenue. With the shift from out-licensing to in-house commercial activities, these companies will further resemble the typical, vertically-integrated pharmaceutical company. Mature biotechnology companies will increasingly compete head-to-head with traditional pharmaceutical companies in certain therapeutic areas.

Additionally, firms previously focused on providing subscription genomic content or drug discovery platform technologies will increasingly focus on direct involvement in the creation of human therapeutics. This will create additional demand for downstream skills and facilities beyond early-stage research.

The most immediate impact of these developments for the Bay Area will be the increasing demand among maturing Life Sciences companies for commercial expertise as well as manufacturing capabilities and capacity. Although there is already a sizeable pharmaceutical manufacturing presence in the Bay Area, there will be a growing need to focus the institutions and infrastructure essential to these requirements going forward.

Moreover, the Bay Area landscape will likely shift—perhaps through increased mergers and acquisitions (M&A) activity—from a large number of small Life Sciences companies to a more limited population of large biotechnology companies and new subsidiaries of large pharmaceutical companies. In the case of acquired Bay Area companies, decisions regarding the location of downstream activities may increasingly fall under the jurisdiction of parent companies located outside of California.

Developing Technologies in Life Sciences

The Life Sciences cluster continues to see the emergence of new sub-technologies, sub-specialties, and entirely new areas of research (proteomics, functional genomics, bioinformatics) as the Human Genome Project continues to bear fruit. This will ratchet up the demand for expertise in emerging areas of basic research. In the longer term, emerging technologies such as gene therapy and stem cell research will also shape the global development of Life Sciences. Regions that position themselves to capitalize on new, greenfield areas of research will be best positioned to benefit in this environment.

As the Life Sciences cluster matures, integration will take place with biotechnology, other technologies, and previously discrete, unrelated markets. Indeed, synergies among biotechnology, chemistry, and Information Technology are already fueling innovation in many areas, from the more traditional pharmaceutical, digital health, and agricultural industries, to such emerging industries as industrial biotechnology, molecular and organic electronics, and DNA and biologically-based computers.¹⁹ Of particular interest to the Bay Area is the convergence of Information Technology and biotechnology that will continue to shape the Life Sciences landscape.

As biology moves from a descriptive to a predictive science, both the resolution and complexity of experimental questions and answers will increase. This means greater convergence in the form of cross-industry technologies and applications such as bioinformatics and nanotechnology, as the boundaries between Information Technology and the Life Sciences continue to blur. Successful regions will, therefore, need to leverage—and integrate—core strengths in the Life Sciences, Information Technology, mathematics, engineering, and other disciplines yet to be determined.

Emerging Personalized Healthcare Model

Therapies developed through Life Sciences are creating higher levels of specialization for targeted patient populations. Biotechnology has enabled the development of many targeted drugs with diagnostic tests to determine *a priori* whether a drug will be effective for a particular patient's genomic profile. An early example of this is Genentech's breast cancer drug Herceptin, which is tremendously effective for a certain subset of patients with HER-2 gene expression. This move towards personalized healthcare will certainly continue as scientists leverage genomic information to gain a more fundamental understanding of diseases' biological processes and of the genes and proteins at play in various disease states. Moreover, as pharmacogenomics yields drugs with a higher probability of success for smaller, targeted patient populations, companies will increasingly need to look to global markets to find patient populations of sufficient size to earn attractive returns. This will have an impact on the Bay Area as the Life Sciences cluster becomes even more global.

Rising Cost of Healthcare

The rising cost of healthcare is an important factor that will influence both the development of and the willingness of the general public to accept new Life Sciences technologies. The primary driver behind this growth in expenditure is the rising expense of hospital care and medical equipment. However, drug expenditures are also increasing, and Life Sciences companies will be forced to justify the high, and rising, cost of their pharmaceutical products.

To be sure, new innovations in treatment may reduce the costs of treating diabetes, cancer, and Alzheimer's disease. But this is not enough. The cluster's answer to rising costs must be three-fold. First, new drugs will need to be more efficacious and more cost-efficient. Second, companies will need to emphasize total patient management economics that demonstrate the overall system cost savings that pharmaceutical products can produce when expensive hospital visits are avoided. Third, there must be a decrease in the cost and time required to develop new pharmaceutical products.

The current cost of developing and bringing to market a novel therapeutic can reach a fully burdened expense of up to \$800 million. To flourish, Life Sciences companies will have to reduce this overall expenditure through more efficient discovery processes and better overall pipeline attrition rates. All of these improvements are necessary to address the growing downward pressure from society on drug reimbursements and prices. They are essential to protect the current phenomenal rates of growth. Other components of the Life Sciences cluster, such as device and equipment manufacturers, will, of course, also need to help create more efficient development processes.

Change in Funding Model

The current venture capital model is, to a degree, inconsistent with the capital requirements of Life Sciences research in a start-up environment. Traditional venture capital typically requires an exit strategy in the relatively near term, even though clinical trials and FDA approval (only one step in the drug development process) for a single one therapeutic agent can take up to nine years. These contrasting timelines and misaligned incentives often cause developing Life Sciences companies to aggressively pursue a first positive discovery. They must be able to develop value claims in order to raise additional funding and go public within a reasonable period of time.

This is why, during the next decade, even if there is no major change in the venture capital model for Life Sciences, there will be a broadening of the sources that fund biotechnology. Larger corporations are increasingly likely to provide capital through joint ventures or acquisitions, and angel investors may step in to fund Life Sciences ventures where timelines are inconsistent with venture capital requirements.

Changing Regulatory Environment

The national and international regulatory environment will continue to influence the development of Life Sciences. Constraints on controversial research, including stem cells and genetically-modified foods, will help determine a region's breadth and depth of scientific expertise in certain areas. Other parts of the globe will certainly embrace this research if the U.S. chooses to de-emphasize it, but the long-term effects of trends like the shift in stem cell research towards China and other non-U.S. regions are unclear. To date, California has been very progressive in its support of stem cell research and other developing technologies. The evidence, however, suggests that the movement towards stricter regulations in the U.S. as a whole relative to other countries will likely continue and, perhaps, intensify.

International regulatory trends will also grow in importance. It seems probable that markets will converge on a global set of regulatory standards that govern how therapeutic agents are brought to market.²⁰ In addition, there will likely be a convergence in the kinds of clinical trial data used in various countries. As a result, the overall process of drug approval should become more standardized across various geographies. Increasing numbers of U.S. companies are already conducting at least a portion of their clinical trials in Europe to shorten overall time to market. Over time, this international clinical trial presence will give U.S. companies greater access to international resources and so encourage them to move a greater percentage of their operations overseas. This trend presents a challenge for the region to remain attractive to Life Sciences companies already located in or considering locating in California.

International intellectual property rights also represent a major uncertainty. How these legal rights develop will do much to shape the extent to which Bay Area firms address new, international markets in the next ten years, particularly in developing nations.

Growing Public Interest in the Ethics of Life Sciences

Public perception of the Life Sciences continues to be an important factor shaping regulatory control, access to expanded markets, and the availability of a capable and willing workforce. The rift in public opinion with regards to biotechnology, particularly stem cell research, cloning, and genetically-modified foods, is getting larger. There is a clear danger that the rift will get larger still as research programs and commercial activities accelerate.

One particular area of public interest is regenerative medicine, the replacement of damaged cells by genetically similar, yet functional, cells. This could be achieved by using embryonic stem cells from cloned human embryos or from highly versatile adult stem cells. Although the potential uses for stem cells are significant, the use of embryonic stem cells for therapeutic purposes does raise some fundamental, ethical questions about the proper uses of embryos in the context of society's medical needs.²¹

Much of the concern about Life Sciences is grounded in fact and in differing judgments about the ethical treatment of various scientific endeavors. Some concern, however, is the product of miscommunication between industry and the public. The extent to which public opinion will embrace the advanced research needs of the Life Sciences depends on the cluster's ability to reach out to the community, educate it, and engage it in open debate. This is particularly true in the Bay Area. To ensure the continued success of the region's Life Science cluster, industry, government, and the public will need to communicate openly so as to develop a shared vision of what is do-able — and what is right to do.

Increasing Competition from New Regions

Other U.S. regions have been developing strategies and taking actions to build and nurture Life Sciences clusters. In each case, as Exhibit 7 illustrates, state government has played a key role in the efforts to capture and catalyze Life Sciences growth. These state-level initiatives share a common focus on:

- Appropriating tobacco settlement funds for Life Sciences research and development.
- Finding vehicles for addressing the financing needs of the industry.
- Supporting the facilities needs of the industry at all stages of the business cycle.
- Providing increased funding for state research institutions and centers.

In addition, each state has identified approaches for addressing specific weaknesses in order to improve overall Life Sciences competitiveness.

Three decades ago, the Life Sciences cluster consisted, in effect, of a group of start-ups in the U.S. that used genetic engineering to produce human protein drugs. Today, the Life Sciences have burgeoned into a global industry with more than 4,000 companies throughout the U.S., Canada, Europe, Australia / New Zealand, and Asia that apply revolutionary science and technologies to diverse fields such as agriculture, environment, health care, and industry. Exhibit 8 illustrates this growing global activity.

Exhibit 7: Examples of Domestic Competitor Regions' Initiatives

State	Examples of Research Strategies	Examples of Finance Strategies
Alabama		■ Alabama Site Development Program (Facilities).
Alaska		■ Alaska Growth Capital (Facilities).
Arkansas		■ Arkansas Capital Corporation (Facilities). ■ Tax-credit for constructing biotechnology facilities.
Connecticut		■ Biotechnology Facilities Fund (Facilities). ■ TSF.
Delaware	■ \$85 million to the Delaware Biotechnology Institute.	
Georgia	■ \$300 million for endowments for Eminent Scholars and building state-of-art laboratories and core research facilities.	
Illinois	■ Part of \$2 billion, 5-year VentureTECH initiative to fund Post-Genomics Institute, Biomedical Research Facility, Medical Resonance Imaging Center.	■ TSF.
Maryland		■ Economic Development Opportunities Fund (Facilities). ■ Maryland Industrial Development Finance Authority (Facilities). ■ TSF.
Massachusetts	■ Mass Life Sciences initiative (collaborative private sector and government initiative). ■ New England Healthcare Institute.	■ Mass Development (Facilities). ■ TSF. ■ Publicly Supported Fund: BioVentures Investors LLC.
Michigan	■ \$59 million to fund 5 laboratories with specialized equipment.	■ TSF: \$50 million per year for a 20-year effort to develop Michigan Life Sciences Corridor .
New Jersey		■ NJEDA Technology Funding Program (Facilities). ■ Tenant Outfit Allowance at Technology Center of NJ (Facilities). ■ TSF.
New York	■ \$15 million for 4 Strategically Targeted Academic Research Centers with bioscience focus.	
Ohio		■ TSF: \$4.4 million then \$24.3 million into biomedical and technology transfer fund . ■ Publicly Supported Fund: EBTC Bioinvestment Fund; BioVentures Development Fund.
Pennsylvania		■ Multiple economic development programs (Facilities). ■ TSF.
Texas	■ \$800 million for science, engineering, research and commercialization activities of which \$385 million to construct and expand research and science facilities.	
Wisconsin	■ \$317 million to build series of state-of-the-art research centers at University of Wisconsin at Madison.	■ Technology Development Loan Program (Facilities). ■ TSF. ■ Publicly Supported Fund: State of Wisconsin Investment Board.

Note: TSF refers to Tobacco Settlement Funds

Source: State Government Initiatives in Biotechnology 2001; CTICA; Signs of Life: The Growth of Biotechnology Centers in the U.S., Brookings Institute

Consequently, centers of innovation, such as the Bay Area, no longer compete solely with domestic rivals. Establishing a Life Sciences cluster as a core component of economic development is an explicit priority of more than 100 cities and regions around the world (Exhibit 8). Most of these regions already focus on California and the Bay Area as a source from which to recruit talent, companies, and ideas to jump start their industries. During the next ten years, this competition for talent, ideas, and innovation will intensify.

Exhibit 8: Examples of Global Competitor Regions' Initiatives

Region	Examples of Government Role
Canada	<ul style="list-style-type: none"> Government funds and coordinates majority of early discovery research. In 2001, Canadian National Research Council committed continued financial support to Life Sciences Industry. \$76 million allocated towards National Institute of Nanotechnology. \$63 million committed to improve infrastructure of Lava Technology Park. \$190 million to create Genome Canada to increase research activity in genomics.
Europe	<ul style="list-style-type: none"> Public policy decisions have shown strong support for Life Sciences industry. Europe unveiled strategic vision for future of European biotechnology up until 2010. France alone has allocated \$130 million to create more start-ups and improve critical mass of its mature biotech.
Israel	<ul style="list-style-type: none"> Office of the Chief Scientist supports many biotech start-ups in early stages. Several first class scientific research institutions. High per capita expenditure on R&D.
China	<ul style="list-style-type: none"> Government has devoted great efforts to research and development of Life Sciences and its commercialization. In the past two years, China has invested 10 billion yuan in Life Sciences. China is only developing country participating in international human genome project. Government funds nearly 200 major biotechnology laboratories.
Japan	<ul style="list-style-type: none"> Government investing \$2.4 billion in science and technology over next five years. Reforms of Japan's science and technology efforts to encourage academia-industry cooperation and encourage entrepreneurship.

Source: Beyond Borders: The Global Biotechnology Report 2002, Ernst & Young; Beijing Times; Bridging the Gap
Ernst & Young 1999

Expanding International Scope of Bay Area Companies

Bay Area Life Sciences companies are actively moving into new international markets for pharmaceutical products. The U.S., Europe, and Japan currently represent a large portion of global pharmaceutical sales, and these regions will remain strong markets over the next ten years. The large populations of China and other parts of Asia represent markets for human therapeutics, and Bay Area firms will move to address them by entering a complex web of sales and marketing arrangements. They will also begin to locate portions of their operations in these new geographies. These developments can benefit the Bay Area by bringing a more global set of companies to establish headquarters here, but they can also damage the region if companies shift their operations out of the Bay Area. This is a particular risk for later-stage business cycle activities such as manufacturing.

Together, these nine trends carry significant implications for the Bay Area and its Life Sciences cluster. Most significantly, they imply a much more complex environment, which in turn requires more and better-integrated planning.

3 THE CASE FOR ACTION

To frame a strategy for bolstering the region's competitiveness in the Life Sciences, it is necessary, first, to build a clear understanding of the Bay Area's current strengths and weaknesses as a host environment for all economic activities. It is also necessary to establish the relative importance of each factor named to the region's competitiveness. Thus, the Monitor Group interviewed more than 59 senior executives in biotechnology companies, universities, industry organizations, service providers, and government, probing on the eight critical factor conditions described earlier (p. 2). The Monitor Group also circulated a web-based survey, which had been proven useful in other parts of the country, to industry executives in the Bay Area. Then, on December 3, 2002, the Governor of California hosted a summit in Menlo Park for Bay Area Life Sciences leaders to discuss the need for planning and collaboration at the Life Sciences cluster level. Collectively, more than 120 institutions have participated in this effort and provided many of the insights described in the following pages.

Survey Results

Surveys of Life Sciences leaders in several regions across the nation reveal similarities in the perception of regional strengths and likely future threats. For example, in every region, these leaders found research facilities and qualified scientists and engineers to be sources of strength. In every major

Exhibit 9: Life Sciences Cluster Leaders' Perception of Regional Strengths and Threats

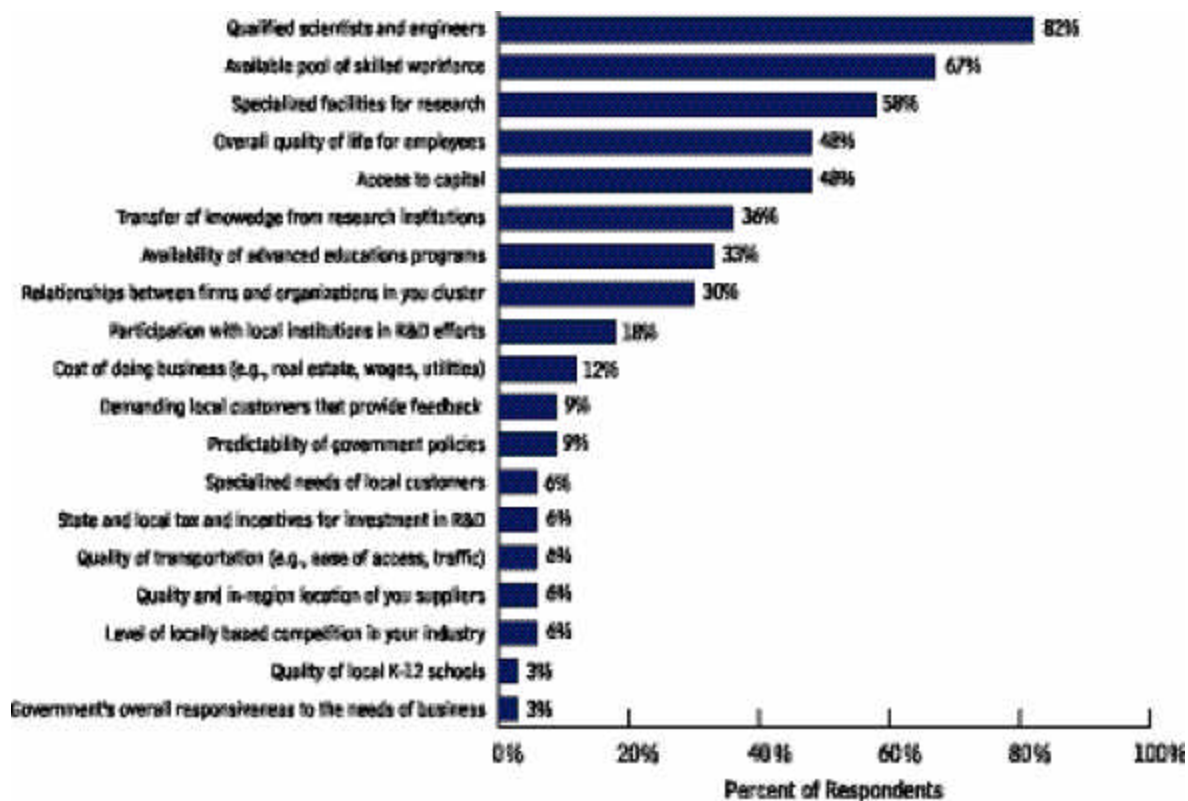
Strengths/Threats	Bay Area	San Diego	Boston	Research Triangle
Top Strengths	Qualified Scientists and Engineers (82%)	Qualified Scientists and Engineers (79%)	Qualified Scientists and Engineers (91%)	Quality of Life (67%)
	Skilled Workforce (67%)	Transfer of Knowledge from Research Institutions (63%)	Specialized Facilities for Research (70%)	Qualified Scientists and Engineers (55%)
	Specialized Facilities for Research (58%)	Specialized Facilities for Research (54%)	Transfer of Knowledge from Research Institutions (60%)	Specialized Facilities for Research (40%)
Top Future Threats	Cost of Doing Business (88%)	Cost of Doing Business (95%)	Cost of Doing Business (81%)	Cost of Doing Business (60%)
	Quality of Transportation (58%)	Quality of Transportation (65%)	Skilled Workforce (47%)	Quality of Transportation (60%)
	Skilled Workforce (45%)	Skilled Workforce (44%)	Government Responsiveness (47%)	Quality of K-12 Education (47%)

Note: Percentage refers to the % of respondents who cited the respective strengths/threats as one of the top five for that particular region.
Source: Clusters of Innovation Regional Quantitative Survey

region, there were concerns about the cost of doing business and the quality of transportation (See Exhibit 9 on previous page for these comparative listings.)

For the Bay Area, the greatest strength is the region's intellectual infrastructure. Eighty-two percent of respondents cited qualified scientists and engineers as the factor having the greatest positive impact on business success: 58% placed specialized facilities for research among the top five. A second perceived strength of the Bay Area Life Sciences cluster is its skilled workforce: 67% of respondents listed the available pool of skilled workforce among the top five factors currently having a positive impact on their firms' success. Also important were quality of life and access to capital (Exhibit 10).

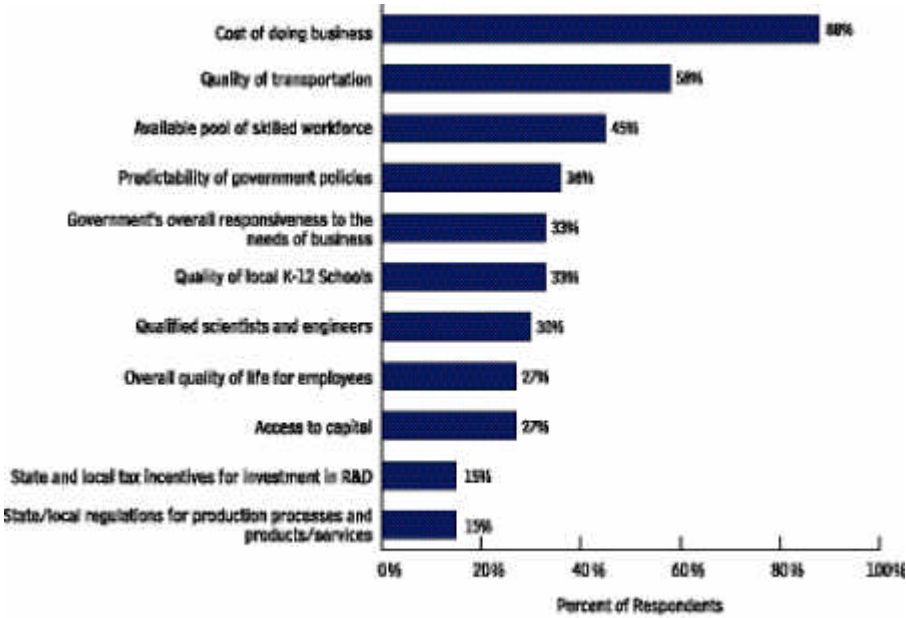
Exhibit 10: Life Sciences Cluster Leaders' Perception of Current Strengths in Bay Area



Source: Bay Area Life Sciences Clusters of Innovation Quantitative Survey, 2002

At the same time, a strong majority (88%) of Bay Area respondents named the cost of doing business as one of the five most important future threats to their businesses, and 58% expressed concern about the quality of transportation. Bay Area leaders also said that, although the current pool of skilled workers is adequate, continuing to find sufficient skilled employees could well pose a threat over time (Exhibit 11). [Additional survey results may be found in Appendix D.]

Exhibit 11: Life Sciences Cluster Leaders' Perception of Future Threats in Bay Area



Source: Bay Area Clusters of Innovation Quantitative Survey, 2002

Confirming these survey results are the opinions expressed in the more than 59 interviews conducted with senior executives, leaders of academic institutions, top-level government officials, and other cluster leaders (Exhibit 12). It is important to note, however, that the pattern of strengths and weaknesses thus identified is not perfectly consistent across all nine counties in the Bay Area. Exhibit 13 summarizes these intra-regional differences.

Exhibit 12: Selected Interview Quotations

	Survey Findings	Interview Quotations
Capital Structures and Resources	Access to capital was ranked as one of the top five factors contributing to the Bay Area's current success in Life Sciences.	"Venture capital companies prefer to invest locally. This is good because there are many VCs in the Bay Area."
Transportation and Information Infrastructure	Quality of transportation was ranked as one of the five greatest future threats to the region's success in Life Sciences.	"Although we [industry] have invested in and collaborated with other companies to create an industrial park shuttle, we wasted a lot of management time. This could have been avoided with proper investments in transportation."
Quality of Life	Quality of life was seen as one of the top five factors contributing to the Bay Area's current success in Life Sciences.	"The Bay Area has a great quality of life. Culture, restaurants, beaches, weather. It has everything."
Intellectual Infrastructure	Intellectual Infrastructure was categorized as one of the premier strengths of the Bay Area for Life Sciences.	"Companies count on university labs to get started. We need them for IP; access to qualified scientists, skilled employees, and for some high tech machinery."

Source: Bay Area Clusters of Innovation Quantitative Survey, 2002

Exhibit 13: Life Sciences Factor Conditions in the Nine Bay Area Counties

	COUNTY								
FACTOR CONDITION	Alameda	Contra Costa	Marin	San Francisco	San Mateo	Santa Clara	Sonoma	Solano	Napa
Capital Structure and Resources									
Commercial and Residential Infrastructure									
Transportation and Information Infrastructure									
Human Capital									
Entrepreneurial Climate									
Technology Commercialization									
Intellectual Infrastructure									
Quality of Life									

— Relative Strength within Region

Alameda, San Francisco, and Santa Clara counties for example, have been at the forefront of both intellectual infrastructure and technology commercialization. The reason: the presence of the region's most influential research universities (UC Berkeley in Alameda, UCSF in San Francisco, and Stanford in Santa Clara). All told, five of the nine Bay Area Counties are especially strong in the key elements (like, leading research institutions, incubators, and anchor firms) that foster a strong entrepreneurial climate. In Santa Clara County, for example, the San Jose Redevelopment Agency has earmarked \$6.5 million for the construction of a bioscience incubator expected to support 10-15 start-up companies. Alameda County, which houses the UC Berkeley and the Advancing California's Emerging Technologies Incubator, has recently secured \$6.4 million in Economic Development Administration (EDA) funding to expand its current facilities and build a 40,000 square-foot, state-of-the-art laboratory. The City of South San Francisco, located in San Mateo County, has also proven to be an excellent location for Life Sciences start-ups, many of which have spun off from Genentech, the region's largest Life Sciences firm.

Exhibit 14: Regional Comparison of Life Sciences Clusters

Factor Condition	Metric	Bay Area	Boston	Research Triangle Park
Capital Structure and Resources	Tax Policy	<ul style="list-style-type: none"> 12% (in-house) and 24% (outsourced) R&D tax credits 6% manufacturing credit 	<ul style="list-style-type: none"> 10% R&D tax credit 3% credit on depreciating assets Single sales factor 	<ul style="list-style-type: none"> 5% R&D tax credit 7% tax credit for machine and equipment taxes
	State-funded Seed capital	<ul style="list-style-type: none"> \$500 million Biotechnology/Healthcare Fund 	<ul style="list-style-type: none"> \$8 million cumulative MBI investment Some state pension fund investment 	<ul style="list-style-type: none"> \$10 million North Carolina Bioscience Investment Fund (\$40 million cumulative investment over time) \$42 million – \$150 million in tobacco-settlement money for investing
	Cost of doing business index* (2001)	136.4	119.1	97
Commercial and Residential Infrastructure	Leasable Wet Lab Space (2001) (millions of square feet)	23	15	5
	Median income as % of Median Home Price	15.4%	18.3%	N/A
Human Capital	Life Scientists employed (1999)	3,090	4,980	1,430
	Life sciences PhD's granted (1999)	215	355	166
Entrepreneurial Climate	Venture Capital – 2001 Rank**	1	4	5
	Gazelle Companies	4	42	48
Technology Commercialization	Anchor research institutions	UC San Francisco, UC Berkeley, Stanford	Harvard University, MIT	Duke University, University of North Carolina, North Carolina State
Intellectual Infrastructure	NIH Grants (2002)	California – \$2.5 billion	Massachusetts – \$1.8 billion	North Carolina – \$0.7 billion
	Number of Patents – 2001 Rank**	2	5	7
Quality of Life	Cost of Living Composite****	San Francisco PMSA – 184.1, Oakland PMSA – 139.5	Boston – 135.5	N/A
	Expenditure per pupil (2000-2001)	California – \$6,255	Massachusetts – \$9,188	North Carolina – \$6,028
	Average classroom size – pupil/teacher ratio	California – 20.8	Massachusetts – 12.4	California – 15.7

Note: *U.S. average Index=100 **Ranking of Top 50 metropolitan areas in the United States
 Gazelle company is company with less than 100 employees growing at 20% or more annually *U.S. average Index=100
 Source: MassBiotech 2010, RCGA, Real Estate Lessons Learned: The St. Louis Regions Market for Wet Labs; Economy.com;
 Bay Area Council; Bay Area Economic Forum; ABAG; Metropolitan New Economy Index; National Institute of Health; ACCRA; College Entrance Examination Board; U.S. Department of Education; National Center for Educational Statistics

Notwithstanding the intra-regional differences laid out in Exhibit 13, each of the nine counties possesses, to an important degree, many of the ingredients necessary for a healthy Life Sciences cluster in the Bay Area. Whether that potential gets realized will be substantially determined by the dynamic manner in which the nine counties work together towards leveraging and addressing the relative strengths and weaknesses most critical to the cluster's continued growth.

Cooperation and coordination will be essential to meeting the growing challenges, such as those posed by the competing clusters in other regions (Exhibit 14). In the face of challenge, there is a clear and unequivocal case for strong, integrated action. The balance of this Strategic Action Plan lays out that case in action-focused detail.

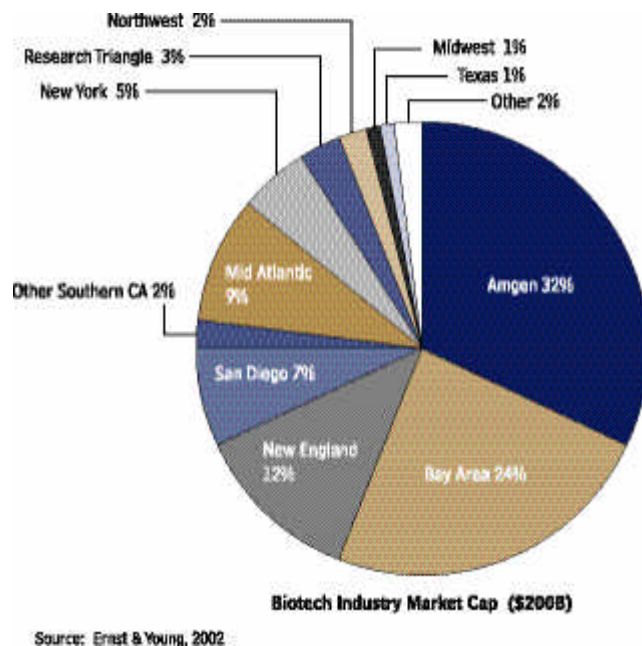
4 CAPITAL STRUCTURE AND RESOURCES

Capital resources are vital to a Life Sciences company's success at every stage of its life cycle. Early on, seed funding is critical to the protection of intellectual property, as well as to the support of the research needed to demonstrate proof of concept. Later, additional capital is needed to see a product through pre-clinical tests, to assemble the necessary workforce, to formalize business operations, to enhance the emerging technology, and to develop both a regulatory and a sales and marketing strategy. Later still, even more financing is required to establish a limited manufacturing capacity, devise a launch plan, and ensure that reimbursement is guaranteed by private and public payers.

STATE OF CAPITAL STRUCTURE AND RESOURCES IN THE BAY AREA

Although the widespread economic downturn is having a significant financial impact on all Bay Area industries, Life Sciences companies are proving resilient and are helping to support an otherwise flagging Bay Area economy. They continued to hire new employees as recently as late 2001 and early 2002 when other technology sectors reported record layoffs and restructuring measures. Admittedly, there are recent signs of a softening in the financial health of some Bay Area Life Sciences firms.

Exhibit 15:
Biotechnology Industry Market Capitalization



Market Capitalization

The overall value of the industry has fallen since reaching a peak in 2000. As of December 31, 2002, the market capitalization of all biotechnology companies in the U.S. was \$200 billion; the Bay Area accounted for \$46 billion or 24% of this total, with Genentech (\$17 billion), Chiron (\$7 billion), and Gilead (\$7 billion) leading the way (Exhibit 15 on previous page).

Capital Markets

Capital markets remain volatile and venture capitalists cautious. Investments now occur more frequently in companies at later stages of product development. This cuts the financial resources available to earlier-stage companies and, by extension, the valuations attributed to them by the market. Indeed, many public Life Sciences companies are trading at or below their levels of available cash.

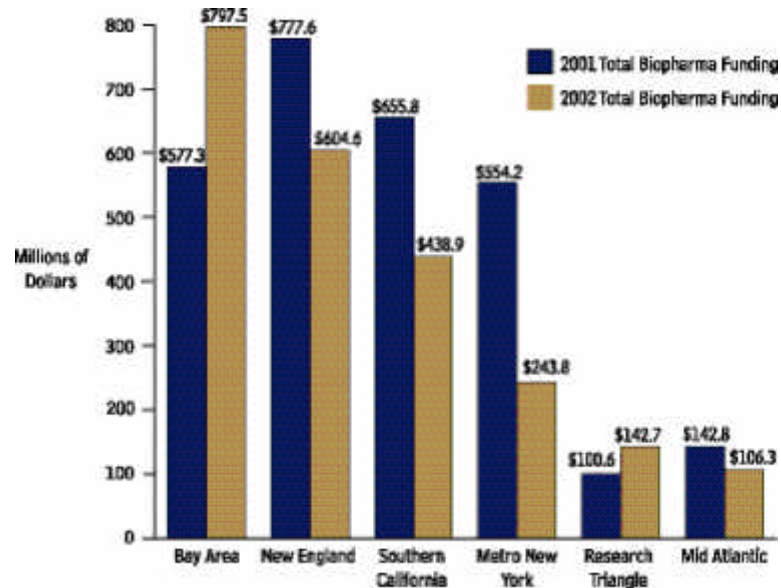
Venture Capital (VC)

The extensive VC network in the Bay Area, which is home to 34% of active VCs in the U.S., has directly contributed to the growth of the region's Life Sciences cluster. This well-seasoned venture community has experienced periods of both robust growth and economic malaise. Throughout the U.S., 84 VC firms raised only \$7.7 billion in 2002, a decline of almost 80% from the \$37.3 billion raised by 232 VC firms in 2001. Even so, the Bay Area's biopharmaceutical companies saw an increase of 38% in 2002 VC funding—the only such community to do so in the country (Exhibit 16).

Venture Capital Model

Despite the significant role VC has played in the start-up of Life Sciences companies, traditional venture capital models are not in complete alignment with the Life Sciences product development process. The existing model fosters reluctance to invest in a company without a clear, near-term exit strategy. This puts pressure on Life Sciences companies to pursue quick discoveries rather than invest in high-potential, but long-term discoveries.

Exhibit 16: Biopharmaceutical Funding by Region



Source: Ernst & Young & Venture One Jan. 25, 2003

Grant Funding

California maintains a wide lead over other states in National Institute of Health (NIH) research funding (Exhibit 17). It also benefits from one of the highest levels of Research Institutional Grants from NIH of any region. This type of research funding has been particularly important to the Life Sciences. Witness, for example, the many private sector innovations that are geographically tied to the leading academic research communities in the Bay Area. But all is not rosy. The number of companies seeking NIH grants in California is heightening the competition among early stage companies with promising technology within the region, as well as with competitor regions.

The University of California (UC) Discovery Grants program administered by the Industry-University Cooperative Research program of the UC office of the President provides another funding option. Through use of research funds and tax credits, and by providing access to UC scientists and students, the program encourages California-based companies to pursue breakthrough research in UC laboratories.

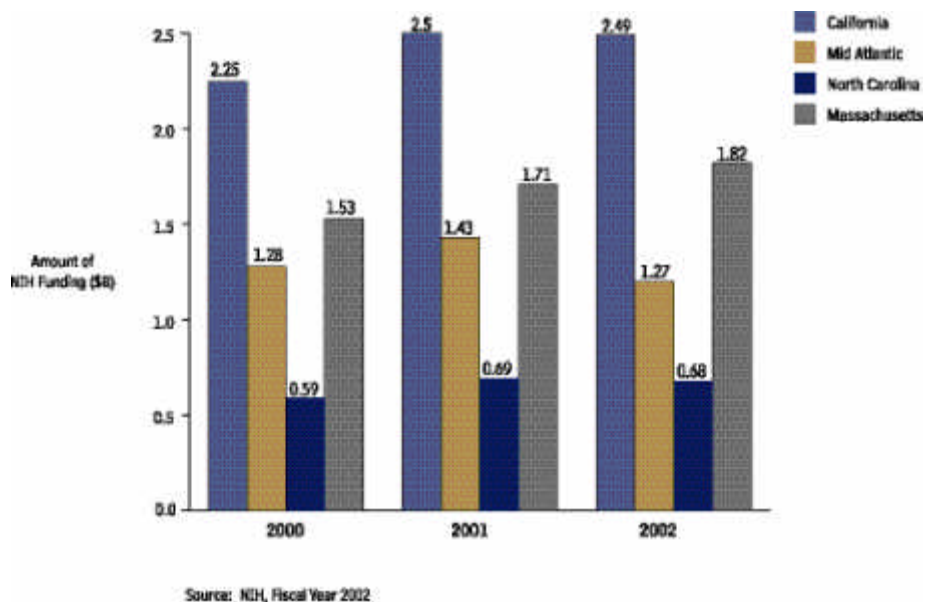
Drug Development Costs

Drug development costs have experienced significant increases throughout the past decade (Exhibit 18). The most current estimate of the cost to bring one drug to market is \$800 million. Inevitably, these costs exacerbate the need for capital by Life Sciences companies. Financing large-scale phase III trials is increasingly difficult—rarely does it occur through venture financing—because these costs are in the hundreds of millions of dollars. These activities are generally funded through the public equities markets and collaborations.

Financing Structure

Venture capital and public equity, as well as IT financing and grants, serve as key current sources of capital. In the past, financing structures such as the Research and Development Limited Partnerships (RDLP) also provided significant funding to companies like Genentech, Amgen, and Genzyme. However, current federal tax law changes have eliminated the structure.

Exhibit 17: NIH Research Grants, by State, 2000-2002



PRIORITY ISSUES AND RECOMMENDATIONS

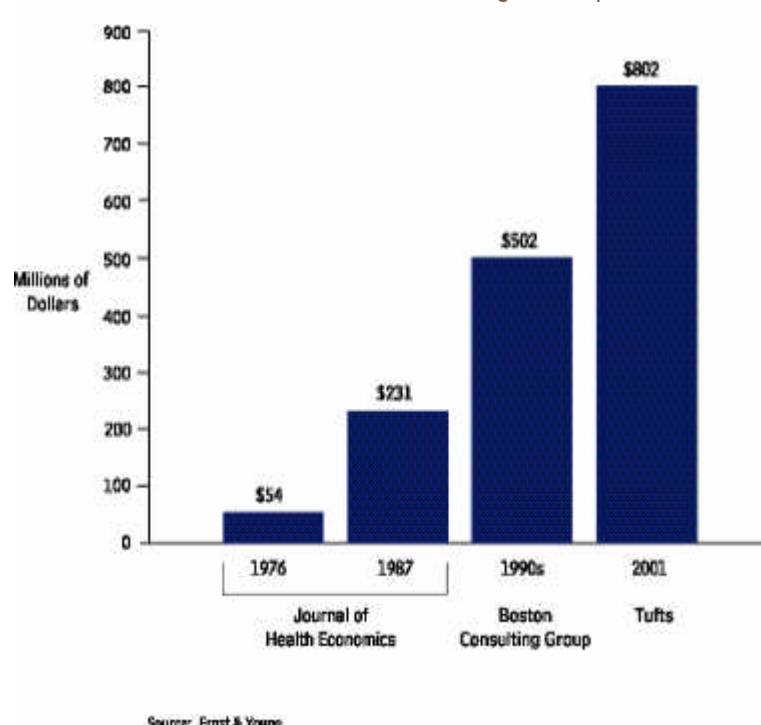
As the Life Sciences mature, companies will face a host of capital-related challenges related to manufacturing and productivity, increased competition, and closer scrutiny by regulators. At the same time, as the industry expands into new technologies, the same companies will need fresh capital to fund early-stage development. Nor is the industry immune to cross-sector challenges such as the flagging economy and an increasingly volatile international political climate.

Given the prospects of new blockbuster products and platform technologies based on genomics and proteomics, the consensus forecast is one of cautious optimism for the Bay Area Life Sciences. But the current climate for investment and the increasing competition among regions for funding underscores the pressing need for fresh capital to bring new products to market. For the foreseeable future, the financial community will, no doubt, continue its guarded approach. That, in turn, puts a great burden of responsibility on state and federal government policy choices. Intelligent, far-sighted choices are essential to provide the incentives for company formation and to attract large pharmaceutical companies to the Bay Area.

Create a better statewide business climate for Life Sciences firms by allowing large Life Sciences companies, either headquartered in California or employing a significant number of Californians, to purchase discounted tax credits/deductions from small R&D firms and, thus, provide those firms with cash.

An appropriate tax structure for Life Sciences firms includes fundable tax credits for research and development (R&D) expenses and net operating losses. R&D and net operating loss credits provide the R&D-intensive firms cash needed to meet the high cost of research. This proposed “convert to cash” mechanism creates two benefits. Early stage companies can sell these tax credits and receive an influx of

Exhibit 18: Trend of Estimated Drug Development Costs



capital to finance the excessive costs associated with R&D. At the same time, larger, profitable companies can help fund early-stage companies in order to obtain their discounted tax credits.

Encourage public (state, local and university) retirement system/investment fund managers to consider additional or first-time investment in the Life Sciences.

Many regions are recognizing the specialized financing needs of the Life Sciences and are creating alternatives to the past heavy reliance on venture capital funds—in particular, by making early-stage financing more available. Increasingly, they are creating innovative programs to address the capital gap in the private marketplace. In fact, more than 25 states have at least one publicly supported seed or venture fund that can be used to invest in Life Sciences companies, and five states have exclusively Life Sciences-related funds (Exhibit 19).

In California, the California Public Employees' Retirement System (CalPERS) has made substantial past investments in Life Sciences through the CalPERS Biotechnology Program. Additional existing vehicles, such as CalSTRS and the San Francisco Employees Retirement Fund, should ratchet up their investment, particularly in small cap Life Sciences companies on the verge of product breakthroughs.

Encourage the state to explore alternative financing structures for the Life Sciences.

If California is to remain financially attractive to Life Sciences companies, the state must consider tax and investment incentives particularly in the area of capital formation.

Capital Access Funds: As other regions recognize the specialized financing needs of the Life Sciences, they are creating alternatives to sole reliance on venture capital funds by making early-stage financing more available. Increasingly, states are creating programs to address the capital gap in the private marketplace. California should consider creating a Life Sciences state investment fund supported by a variety of different mechanisms.

Incubator Financing: California should explore the possibility of combining tax incentives and state funds to finance shared research/manufacturing facilities for emerging Life Sciences companies.

Exhibit 19: Publicly Supported Funds

State	Fund
Existing Funds	
California	CalPERS Biotechnology Program
Massachusetts	BioVentures Investors LLC
North Carolina	NC Bioscience Fund
Ohio	EBTC BioInvestment Fund
Wisconsin	State of Wisconsin Investment Board
Funds Under Development	
Ohio	BioVentures Development Fund

Source: State Government Initiatives in Biotechnology 2001.

Tobacco Settlement Funds: Sixteen states have recently dedicated at least part of their tobacco settlement funds to Life Sciences efforts. Michigan has apportioned \$50 million per year for a 20-year effort to develop the Michigan Life Sciences Corridor. Ohio is allocating \$4.4 million for the first year and \$24.3 million dollars for three subsequent years to its recently created biomedical research and technology transfer fund. California should consider a similar commitment of its funds.

Ensure the state of California's ability to attract and retain Life Sciences companies of all sizes through tax incentives.

Various studies show that the cost of doing business in California is nearly forty percent higher than in any other state in the U.S.. The Bay Area's even higher cost of doing business affects every stage of the value chain. Lowering these costs will have more impact on the number of new companies formed in the Bay Area and on the number of large pharmaceutical companies planning to locate R&D facilities there than any other action step. Among the possibilities:

Single Tax Factor Formula: Change the apportionment formula for corporate income to determine what is taxable in the state of California from the current 3-component formula (property, payroll and double-weighted sales) to a single sales factor formula. As existing Life Sciences companies based in the Bay Area grow, this would eliminate the disincentive to locate additional facilities (such as manufacturing and R&D) and jobs in California rather than moving them outside the state. Additionally, this would make California more competitive with other states in attracting new Life Sciences companies and facilities.

Property and Sales Tax Deferrals for Life Sciences Companies.

Tax Holiday for Relocation Expenses.

Provide creative incentives and financing sources for Life Sciences companies.

Volatility in the capital markets, increasingly cautious venture capitalists, Life Science companies trading at or below their levels of available cash, and the high cash burn rates of such companies tell an important story of the need for creative solutions to funding shortfalls.

Provide incentives for angel investors.

The traditional venture capital model is not conducive to the long-term, yet high-risk, vision required for investment in early-stage Life Sciences companies. Government-sponsored incentives for early-stage "angel" investors would help by growing the pool of capital available for early-stage companies.

Partner with the federal government to capitalize on federal grant programs.

The six Regional Technology Alliances, as well as other such programs, provide an opportunity for taking full advantage of federal grant programs. Federal grant programs tend to give preference to applicants that have partnerships with well-thought-of organizations.

Facilitate alliances between Pharmaceutical (mature) and Biotechnology / Emerging Technology (early-stage / R&D) firms.

Joint corporate financing arrangements between large and small Life Sciences companies can provide the latter with significant sources of capital during the crucial early stages of growth. Tax incentives that would encourage companies to partner "in-state" as opposed to licensing out of state would particularly benefit the region.

5 COMMERCIAL AND RESIDENTIAL INFRASTRUCTURE

The concern for commercial and residential infrastructure has to do with the availability of space for businesses and of housing for a region's workforce. This type of physical infrastructure is particularly critical for Life Sciences companies because of their specialized building and real estate financing needs. In addition, the cluster's heavy reliance on a growing population of skilled workers translates into an increasing need for adequate, affordable housing.

COMMERCIAL INFRASTRUCTURE

For the Life Sciences to flourish in the Bay Area, the necessary plans, incentives, and policies must all be in place to encourage the development of commercial infrastructure that meets today's needs as well as tomorrow's. These needs vary greatly depending on a company's level of maturity. Start-ups and early-stage companies typically require only small work spaces of 2,000 to 10,000 square feet, together with access to wet lab facilities. Large manufacturers often require sprawling, campus-like sites and significant infrastructure support.

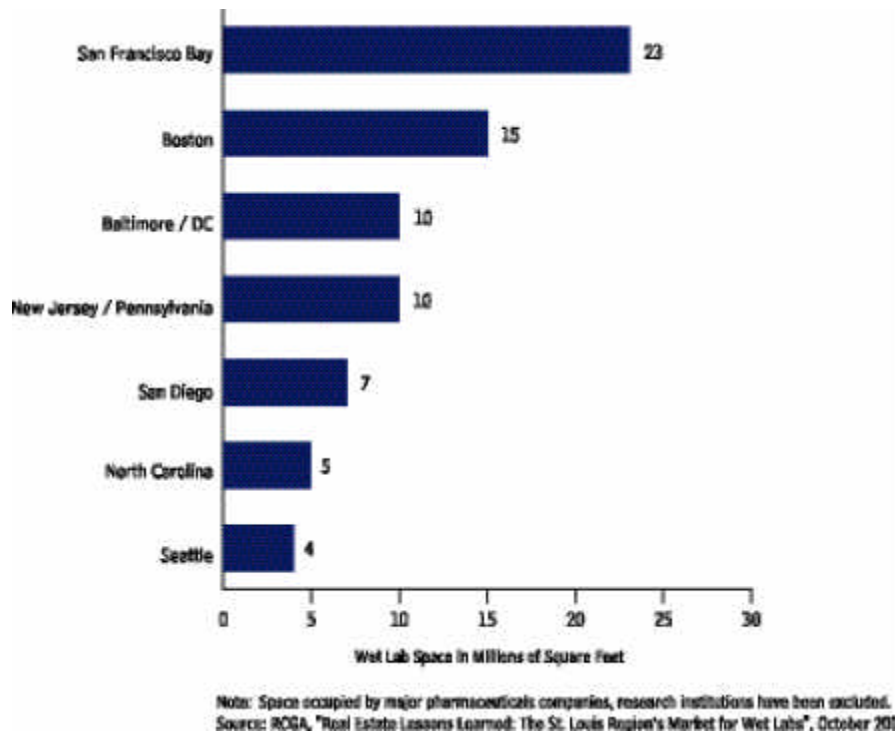
STATE OF COMMERCIAL INFRASTRUCTURE IN THE BAY AREA

Historically, commercial development for the Life Sciences has been robust in the Bay Area relative to other markets. Exhibit 20, for example, shows that the Bay Area market for wet lab space is significantly larger than that in competitive regions. This trend will likely continue. In fact, biotechnology firms, which already occupy over ten million square feet in the Bay Area, could add another one million square feet over the next few years.²⁴

Currently, construction momentum in the region is strong. Bay Area real estate and development communities are familiar with the needs of the cluster, and multiple companies have emerged as specialists in the development of unique Life Sciences space. Projects like Mission Bay in San Francisco, Campus Bay in Richmond, and the Contra Costa Bioscience Incubator are just a few examples of recent Life Sciences-focused developments.

Several concerns, however, have emerged that must be addressed if the region is to continue to attract and retain Life Sciences companies.

Exhibit 20: Comparative Wet Lab Markets



Availability of Lab Space

“The current economic downturn has made space available in general, but there’s still a lack of turnkey wet lab space for startup [biotechnology companies]. Space is sorely needed.”²⁵ Young companies in the Bay Area find it difficult to find small, affordable wet lab space that they can use for short periods of time. The problem is especially acute now in light of the tight venture capital market.

Building wet lab space represents a high-risk investment for private sector developers because the space is highly specialized and expensive to build. This explains why it is typically not built on spec and, indeed, is often entirely leased before construction is complete. Incentives are currently not in place to make it economically attractive for developers to build space that meets the needs of early Life Sciences companies.

Zoning and Permitting Requirements

Inconsistent and uncoordinated zoning and permitting practices are another regional weakness. Bay Area jurisdictions have different building requirements, some of which favor the Life Sciences more than others. Some cities, like South San Francisco, are models of effective commercial infrastructure planning focused on attracting Life Sciences research and development companies. The city’s commitment is exhibited in thoughtful and flexible planning, zoning, and permitting practices. “It is easy to build here. The infrastructure for building is already in place. The contractors can build quickly. South San Francisco has a very cooperative local government,” explained one industry executive. Unfortunately, not all Bay Area cities are as committed to meeting the cluster’s needs.

Manufacturing Infrastructure

The Bay Area is indisputably an attractive place for Life Sciences research and development (R&D); however, it does not currently have a comparable appeal to manufacturing. Although there are benefits for companies that locate manufacturing capabilities near their R&D facilities, the high property values around the Bay Area, the high cost of labor, the lack of tax incentives, the challenges of water supply, and other deterrents threaten to drive manufacturing activity to other regions.

PRIORITY ISSUES AND RECOMMENDATIONS

Further development of the Life Sciences in the Bay Area depends on appropriate facilities being available for companies at each stage of their development cycle. To facilitate the commercial development of such facilities, government must ensure that both the necessary incentives and the necessary planning, zoning, and permitting practices are in place.

Government at all levels, as well as the private sector, has a significant role to play in ensuring that the appropriate commercial infrastructure for the Life Sciences is available in the Bay Area. In particular, wet lab facilities must be developed for start-ups and early stage companies, zoning and permitting best practices must be deployed in multiple cities across the region, and the ability of the Bay Area to meet the needs of maturing Life Sciences companies must be addressed.

Ensure collaboration between industry representatives and local government officials to identify the future manufacturing and distribution needs of the cluster and to determine where the Bay Area should focus.

First, potential locations in the Bay Area that are best suited to meet the needs of large-scale manufacturers must be identified. Possible locations include Contra Costa and Solano Counties, specifically the Richmond to Vacaville corridor, and Alameda County, specifically the Oakland Army Base and Naval Air Station. Counties adjacent to the Bay Area that may also be suitable include San Joaquin and Merced, specifically the Castle Air Force Base.

Manufacturing locations must be close to existing Life Sciences companies in order to leverage the advantage of proximity to R&D facilities. The Clusters of Innovation Survey found that proximity to R&D centers was the most important reason for locating in the Bay Area for 64% of respondents (Appendix D, Exhibit 41). Where possible, locations should also be chosen in counties with lower property costs and significant amounts of available space. The most appropriate locations should be designated as manufacturing zones, and the necessary permitting and zoning requirements should then be put in place so development can happen quickly and conveniently. Offering ready-to-build sites with proper zoning, established sewage, transportation access, and other infrastructure concerns already addressed would be ideal. If the Bay Area hopes to attract Life Sciences manufacturers, it must make speed-to-market a competitive advantage.

Facilitate the development of commercial space for start-up and young Life Sciences companies by encouraging creative public-private partnerships.

Government at all levels can have a significant effect on the development of wet lab space by introducing incentives, such as tenant security enhancements or developer tax credits, that reduce the risks of

development. Similar incentives could make it more desirable for landlords to accept short-term leases or offer smaller parcels of space to early-stage companies.

Creative public-private partnerships could also help spread the burden of development risk between government and the private sector. One possible model would see space provided by the public sector and operated by the private sector. The cost to tenants would largely be the cost of operations, thus improving the location's affordability.

Currently, 15 states have Life Sciences incubators, and 19 have technology incubators that include wet lab space.²⁶ Since building Life Sciences incubators can cost up to four times as much as building other types of incubators²⁷, funding assistance from both public and private sources is mandatory. The development of one incubator funded by public investment, private sector sponsors, and grants is already underway in the Bay Area. The Contra Costa Bioscience Incubator will provide flexible leases and affordable space, as well as support services and business assistance programs, to small entrepreneurial companies during their early stages of growth. By providing more than just space, this incubator will foster a stronger entrepreneurial environment for young companies.

Create a “Life Sciences Infrastructure Best Practices Guide”.

Cities across the state and the country have become magnets of Life Sciences development. Many of these cities have made a commitment to the cluster and have backed this commitment in all of their planning, zoning, and permitting decisions. After examining the reasons these cities have been so successful, the Bay Area must develop a “Life Sciences Infrastructure Best Practices Guide”. The Guide would allow cities interested in attracting and retaining Life Sciences companies to gain a better understanding of what is required of them.

Best practices that should be highlighted in the guide include: regular meetings between industry and government; trained and dedicated city staff responsible for industry inquiries; assignment of a single contact person to aid in permitting or the establishment of a consolidated permitting office; R&D and / or manufacturing zoned areas; and a commitment to consider related infrastructure needs such as transportation requirements and “smart growth” development. If multiple cities across the Bay Area follow these and other best practices guidelines, the region as a whole will be better able to attract and retain Life Sciences companies.

RESIDENTIAL INFRASTRUCTURE

Residential infrastructure — that is, housing — in the Bay Area is a key concern that affects all residents and businesses. Housing costs are extremely high in many parts of the region, especially in the ring of cities and counties around the Bay where most Life Sciences businesses are located.

High housing costs are already eroding the region's competitive advantage and, thus, are not just a problem for individuals. Indeed, for the Life Sciences, the Bay Area's housing crisis is a barrier to growth. In fact, in the Clusters of Innovation Survey, 73% of respondents indicated that, during the next five years, housing affordability was one of the most significant barriers to their firms' expansion (Appendix D, Exhibit 42).

STATE OF RESIDENTIAL INFRASTRUCTURE IN THE BAY AREA

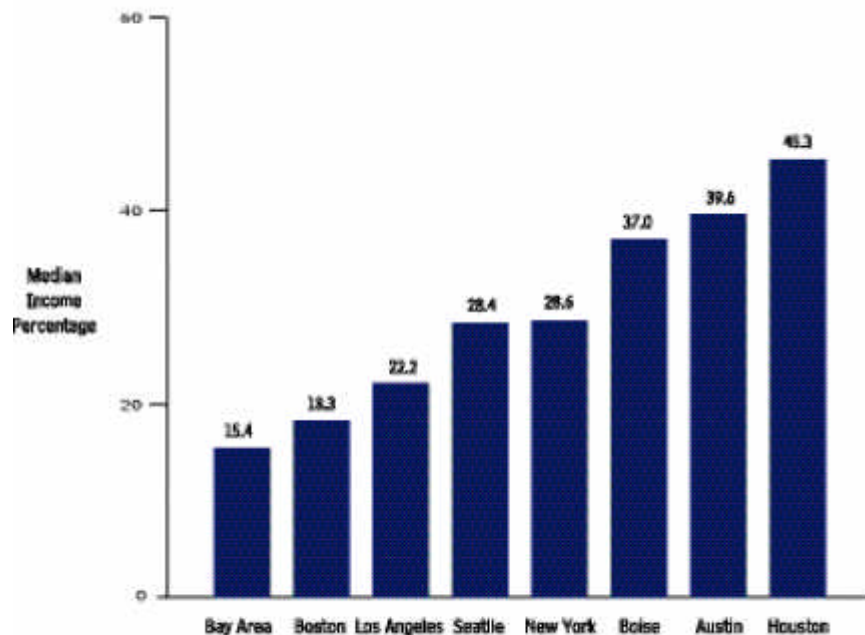
The strong and geographically distributed demand for housing in the Bay Area has not been sufficiently met. A significant jobs/housing imbalance, poor land-use patterns, and inefficient regional planning and funding have led to a serious shortage of affordable residential housing. Although these problems were especially acute in the late 1990s, they remain a significant challenge for the Bay Area.

Jobs/Housing Imbalance

The construction of affordable homes, where residents allocate no more than 30% of their income to housing costs, has not kept pace with demand in the Bay Area. Between 1995 and 2000, the region gained only 148,044 new housing units but generated 600,000 new jobs requiring 400,000 housing units. This resulted in a jobs/housing imbalance and a deficit of more than 250,000 units.²⁸ The housing crisis continues to be poorly addressed. Estimates show that local jurisdictions have zoned for only half the amount of housing needed for the employees who will fill an anticipated one million new jobs by 2020.²⁹

Housing deficits result in strong demand for the limited number of affordable units and cause prices to escalate. Housing prices in the Bay Area are the highest ever on both an absolute and an adjusted basis. Put bluntly, the jobs/housing imbalance is the worst in the history of the region³⁰. Relative to competitive regions, Bay Area residents have the lowest purchasing power in residential markets despite historically higher median incomes (Exhibit 21). In Santa Clara County, for example, only 20% of homes are affordable to median income families (median income is defined as approximately \$96,000 for a family of four).³¹ As a result, businesses suffer as they are pressured to increase salaries to meet employees' household income needs. Inevitably, they have difficulty recruiting and retaining mid-to-low income employees such as lab technicians, middle managers, or manufacturing employees.

Exhibit 21: Relative Purchasing Power, 2000



Source: Bay Area Council, Bay Area Economic Forum, ABAG, "After the Bubble: Sustaining Economic Prosperity" (Economy.com, Population Demographics), January 2002

Poor Land Use Patterns

The housing crisis in the Bay Area is further exacerbated by the region's poor land use patterns. Current patterns are strongly marked by dispersed residential and commercial infrastructure, relatively low-density development far from transit, and abandoned urban cores of major cities and older suburbs. This has resulted in longer commutes, typically by car, increased strain on transportation systems, diminished leisure and work time, and increased environmental pollution. Mobility solutions will become more expensive without a shift to high-density land use. Equally troubling, without improved housing opportunities in urban centers and older suburbs, abandoned neighborhoods will deteriorate further.

Inefficient Local Funding

Financially-strapped local governments, especially those facing uncertain funding sources, tend to review development proposals in light of whether new projects will increase local revenues or strain the system through additional service costs. As a result, the potential of new retail sales taxes appears more attractive than the lower income-generating option of residential development. Not surprisingly, retail development is favored over housing production by many local governments.

PRIORITY ISSUES AND RECOMMENDATIONS

The priority residential issues faced by the Life Sciences in the Bay Area are similar to those faced by all businesses and employees in the region: increasing the availability of affordable housing, ideally close to job centers, and improving land-use planning.

To address these issues, the Life Sciences cluster should support initiatives that encourage “smart growth” planning. “Smart growth” seeks to revitalize already-built environments in central cities and older suburbs and, when necessary, to foster efficient development at the edges of the region. The goal is to create more livable communities and sufficient housing for the region's workforce. This, in turn, places new emphasis on supporting and enhancing public transit, promoting walking and bicycling, and preserving open spaces and the environment.

The Bay Area's five regional agencies and the Bay Area Alliance for Sustainable Development have done much work in the area of “smart growth” planning and have a clear vision for the future. The Life Sciences cluster should support the goals of the Smart Growth Strategy Regional Livability Project and should advocate that actions be taken to meet those goals. Summarized below are some of the highest priority “smart growth” recommendations.

Most of the action items suggested require changes to government incentives. Even so, there is every reason to believe that many of these strategies can be implemented within the ten-year time frame of this plan if they receive the requisite support. It is important to move on them—and to move on them in an integrated, coordinated way. “Smart change” is a systems problem and requires a systems solution.

Introduce incentives to increase the supply of affordable housing.

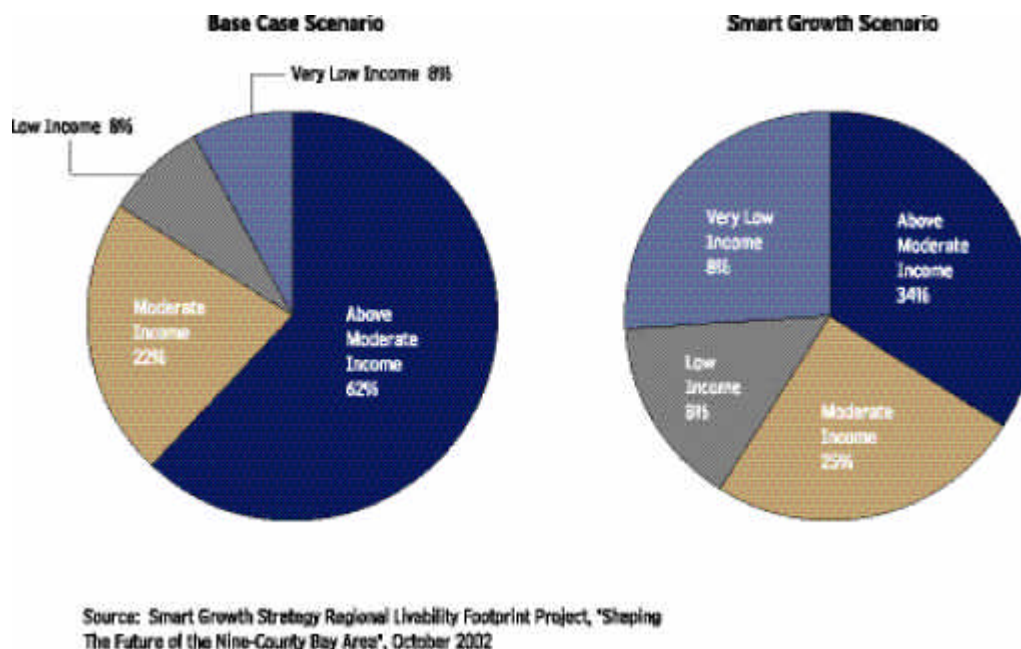
State/local financing agreements currently favor retail development over housing development. However, giving local governments back their share of property taxes could encourage them to look more favorably upon new housing as a source of revenue to pay for public services. Amendments to the state constitution could protect locally-levied taxes from being reallocated and, so, remove a major disincentive

to the building of residential infrastructure. In addition, improving revenue stability by returning Educational Revenue Augmentation Funds (ERAF) to local governments, restoring state support of public schools through other means, and increasing the proportion of property tax revenue in local government budgets could help alleviate the situation. Local government funding could also be linked to progress in housing development or, more specifically, to a county's fulfillment of its fair-share housing obligations.

Amendments to streamline approval processes, such as amendments made to the California Environmental Quality Act (CEQA) approval process for affordable housing projects, could also encourage greater residential development. Two other ideas, which are currently in place in some Bay Area cities, are introducing inclusive zoning laws that require new housing developments to include a certain percentage of affordable units and jobs-housing linkage fees that require new job-generating projects to pay a fee towards affordable housing development.

The Smart Growth Strategy Regional Livability Project estimates that during the next two decades 28% more affordable homes will be built under the smart growth scenario than if the status quo were maintained (Exhibit 22). This provides strong reason to support the initiative.

Exhibit 22: Affordability of New Housing Units



Increase public acceptance of affordable housing.

As long as community members are resistant to change, even the most well-planned developments may be derailed. Advocates of affordable housing and "smart growth", including politicians, business leaders, and other community figures, must speak out about the importance of increasing the supply of affordable housing in the region. Communities need to understand better the link between affordable housing and

healthy neighborhoods. Local government needs to support the development of housing projects by clearly articulating—through publicly available media, such as flyers, newspaper ads, and television—the benefits of particular projects and their importance to the region as a whole.

Influence decision-makers to make “smart growth” residential planning choices.

Residential development needs to be built near job centers and / or near transit, at higher densities, and in mixed-use environments. Where possible, it should take advantage of existing urban or suburban development. To encourage this kind of smart residential development, the state, county, and local area governments need to influence all relevant decision-makers to make smart development choices by changing building requirements, policies, and incentives.

For example, to encourage development near transit, governments should amend parking standard requirements. Residents living next to transit require fewer cars and, therefore, need fewer parking spots. Since parking spots use valuable land and can cost up to \$25,000 per space³², reducing the number of spots required per unit benefits developers and encourages increased development near transit.

Similarly, local governments should be rewarded for approving new residential and commercial development near transit stations. New transportation funding could be used to encourage mixed-use development around rail and bus hubs. State- and federally-funded transportation programs, such as the Metropolitan Transportation Commission’s (MTC) Transportation for Livable Communities and Housing Incentives Programs, should be expanded through increased funding. Government should also reward developers and industry through tax credits or grants for building adjacent to transit.

Other suggestions such as introducing minimum density requirements, allowing higher density development, and enacting urban growth boundaries would also help to ensure sustainable development in the region.

Revitalize underused and deteriorated urban areas.

The suggestions set out above focus on the development of greenfield sites. It is also important to consider infill development in urban cores. This is particularly relevant to the Life Science cluster, given its geographic history in urban and suburban regions around the Bay. Local governments should quickly take a number of practical steps. In particular, they should identify potential sites for infill development, rezone unused industrial areas and underutilized shopping strips for new mixed-use development, and adopt ordinances to allow the development of second units without complex or expensive approval processes. For infill developments involving contaminated brownfield sites, state funds should be available for the clean up of sites suitable for housing uses, and limits on the liability of developers for prior contamination should be reevaluated. As an inducement to develop such sites, some local governments like Emeryville already post on their websites the location of vacant parcels and their soil analysis information.

6 TRANSPORTATION AND INFORMATION INFRASTRUCTURE

Transportation and information infrastructure affect the movement of people, goods, and information throughout a region. Their related networks are critical to the flow of human capital, intellectual capital, and products. Although some unique needs—specific transportation links, for example, for the South San Francisco or Mission Bay Life Sciences parks—do exist, most requirements apply to Bay Area industry generally, not just to the Life Sciences cluster.

However, in their interviews, web-based survey responses, and Summit discussions, Bay Area Life Sciences leaders stressed the critical importance of transportation infrastructure as a potential constraint on their companies' growth. They also pointed to specific ideas for improving the Bay Area's transportation infrastructure and insisted that their voices be heard in the discussion of these topics.

TRANSPORTATION INFRASTRUCTURE

Transportation infrastructure enables the movement of people and goods from one place to another. Well-functioning transportation networks are critical prerequisites to successful economies and major influences on the quality of life in a region. Unfortunately, in the Bay Area this is a serious cause for concern. Troublesome limitations here already negatively affect the region's economic vitality, global competitiveness, and quality of life. This was particularly evident in the Clusters of Innovation Survey, where 58% of respondents indicated that the quality of transportation was one of the greatest threats to their businesses (Exhibit 11).

STATE OF TRANSPORTATION INFRASTRUCTURE IN THE BAY AREA

The Bay Area's current transportation infrastructure is comprised of several multimodal networks. These include: miles of local streets and highways, bridges, seaports, three international airports, miles of transit and paratransit routes, and two major regional bicycle and pedestrian trails. This provides a strong base from which to work. Although additional transportation capacity will certainly be needed, there is significant opportunity to improve the efficiency of what is already in place. Focusing on maintaining and increasing the efficiency of the current system so as to get maximum utility from sunk investments should be one of the region's top priorities.

Strong Public Acceptance of Transit

From county to county, use of public transit varies from 2% to 32%. Even so, the Bay Area as a whole values the importance of public transit. A Bay Area Metropolitan Transportation Committee (MTC) poll

conducted in May 2001 asked what type of transportation system improvements residents would like to see. Expanding commuter express bus services was of high priority to 61% of respondents; 67% pointed to expanding rail services; and 79% named expanding BART services. Overall, 86% of respondents agreed that the sooner public transportation systems were improved, the sooner congestion could be reduced.

Despite some strengths, the region's unpleasant and uneconomic transportation infrastructure ranks as one of its greatest competitive weaknesses. Regions within the Bay Area regularly emerge at the top of lists of the nation's most congested areas. The Texas Transport Institute's 2002 Urban Mobility Report, for example, ranked the San Francisco-Oakland region as the second most congested location in the U.S. (a position the region has held since 1985). It ranked San Jose as the fourth most congested. The report also estimated that traffic congestion costs commuters \$3.2 billion annually in San Francisco-Oakland and \$1 billion in San Jose in wasted fuel and time. In 2002, the Census Bureau and the MTC estimated that Bay Area commuters spend more than 155,000 extra hours (almost 17 years) in traffic per day. In 2000, more than 11% of Bay Area workers commuted at least two hours per day³³

Recently, there have been some improvements in congestion levels, but they are largely the result of the region's economic slowdown. True, the slower economy has eased the strain on the region's transportation system, but it has also led transit agencies to delay improvements and reduce or eliminate transit services. Thus, when the economy recovers, congestion will be worse than ever. By 2025, region-wide travel will have to increase by 30% and trans-Bay travel by 40%.³⁴ The current transportation system will simply not be able to handle this heightened level of demand.

Incomplete Transportation Networks

Several transportation networks in the Bay Area, including light rail, are incomplete and inefficient, which makes it difficult for commuters to access all parts of the region conveniently. For example, high occupancy vehicle (HOV) lane gaps mean that services, such as express buses that use HOV lanes, cannot be offered consistently across the region.

Minimal Deployment Of Intelligent Technology Systems (ITS)

Deploying information technology sensibly is an effective way of improving the current transportation system at relatively minimal cost. True, there have been sporadic investments in ITS, including the FasTrack electronic toll collection program and the NextBus initiative. Still, it is ironic that the Bay Area has not leveraged its historic leadership in Information Technology (IT) to keep pace with even the minimum levels of investments made by comparable regions. As the San Francisco Business Times noted, "When it comes to leveraging Information Technology to improve mobility in the region, the Bay Area is mysteriously at the bottom of the heap, failing to exploit even the basic Intelligent Transportation Systems (ITS) technologies that are common in other major U.S. cities."³⁵

Inadequate Coordination Among Independent Transit Operators

Many of the problems frequently cited regarding Bay Area transit are often attributed to inadequate coordination among the region's various independent transit operators. Concerns include route synchronization, fare payment, trip planning, and uncoordinated marketing strategies. Several preliminary steps are underway to try to ease the use of the system, including TakeTransit and TransLink, but these initiatives have only just begun to address the issue.

Insufficient and Unstable Transportation Funding

Historical under-investment in transportation infrastructure continues to be a problem across the Bay Area. Securing the necessary funding for large-scale transportation projects is extremely difficult despite the pressing need for improvements. Most current funding structures rely heavily on sales taxes, which are highly unpredictable. In order to plan for future infrastructure investments, transportation agencies need more stable funding sources.

PRIORITY ISSUES AND RECOMMENDATIONS

Transportation weaknesses clearly and visibly detract from the Bay Area's other strengths. For the Life Sciences, the single most important issue here is to improve travel convenience, especially for commuters to, from, and within the areas around the Bay most important to the cluster.

The large-scale improvements needed to meet this goal will require huge financial commitments and will take longer to implement than the ten-year scope of this plan. The recommendations outlined below focus on shorter-term alternatives, which can be accomplished within ten years and which, relatively speaking, do not require securing vast amounts of new, long-term funding.

Support initiatives to improve public transportation and relieve traffic congestion.

Several initiatives and committees have developed plans to address the transportation infrastructure issues in the Bay Area. This region-wide issue is also at the forefront of challenges that Bay Area Life Sciences leaders would like to see addressed.

Expand deployment of intelligent transportation systems (ITS).

Deploying ITS in the Bay Area, by introducing "smart" technologies such as electronic toll collection, traffic signal coordination, ramp metering, and systems monitoring, will measurably improve the efficiency of the current transportation infrastructure. The first step is to develop a comprehensive ITS master plan for the region. The Bay Area Freeway Concept of Operations report recommends the development of just such a "Regional ITS Architecture" to ensure compatibility between systems and the sharing of data between appropriate institutions. The report proposes the MTC as the lead agency for this effort.

The development of an ITS architecture for the region is important but complex. It will need to address system monitoring and management, traffic signal coordination, ramp metering, and electronic toll collection, as well as funding mechanisms over time. It will also require buy-in from all relevant stakeholders including Caltrans and the Highway Patrol.

Introduce market-pricing mechanisms.

Market-pricing will reward motorists for making more efficient travel choices. It can take many different forms, such as implementing variable toll pricing on bridges and tolls for single occupancy drivers wishing to use HOV lanes.

Introducing variable pricing on toll bridges means charging higher tolls at peak hours, thereby providing an incentive for drivers to shift their travel patterns away from peak periods. If successful, this system would encourage people to take public transit or ride share and would help to alleviate congestion, especially in the ring of cities most important to the Life Sciences cluster. Increased tolls would also generate additional revenue, which could be reinvested in large-scale capital projects.

Implementation requires a change in pricing practices and state authorizing legislation. Currently, a bill to introduce a flat rate increase in the price of tolls is before the Legislature. Amendments to this bill to include legislation for implementing variable toll prices on area bridges should be encouraged. This requires lobbying and educating the key decision makers.

Introducing market-pricing to under-capacity HOV lane networks would mean charging a special toll to solo drivers wishing to take advantage of the increased convenience of HOV lanes. The I-680 (Sunol Grade) is the most likely location to introduce a high occupancy toll (HOT) lane within the next couple of years. The Alameda County Transportation Authority is in the process of seriously evaluating the feasibility of doing so. If adopted, this HOT lane would essentially serve as a pilot project for further roll out.

Study transit operator coordination and create an action plan.

Poor coordination between the Bay Area's numerous public transit operators is often cited as a significant contributor to the system's inconvenience and inefficiency. The magnitude of these problems, however, is not well understood, nor are possible solutions clearly articulated. A comprehensive study of the current public transit system and the causes of its inefficiency is required. The study should examine both the challenges faced and provide an action plan for improvement. The plan should be specific, including consideration of timelines for implementation and sources of funding. The MTC is a likely candidate to lead this initiative. Progress can be easily made on this topic within two or three years.

Increase water transit on San Francisco Bay.

On December 11, 2002, the Water Transit Authority (WTA) delivered its Implementation and Operation Plan to the State Legislature. The plan proposes a well-integrated water transit system that provides good connections to other transit, is cost-effective, environmentally responsible, and provides enhanced commuter choice. The plan proposes expanding current routes and introducing seven new routes at a cost of \$665 million over ten years.

The Bay offers a unique transit option to the region that can greatly facilitate commuting between communities along its shores. The regions that will be most affected by enhanced water-transit are the areas most relevant to the Life Sciences cluster. Thus there is every reason for cluster leaders to advocate strongly for the approval of the WTA's plan.

To be implemented, the plan must be approved by the Legislature. If approved, the first service could begin within three years of funding, depending, of course, on findings about environmental impact, and on local support and commitment. Funding will likely come from new transportation dollars from federal, county, local, and private sources. A portion of the newly-generated toll revenue implied by a market-pricing plan, for instance, could be put towards water transit. The Federal Ferry Boat Discretionary Fund must also be expanded, and the Bay Area must obtain a set-aside for its water transit system. Finally, the WTA must continue to seek new funding sources.

Generate additional and stable transportation funding.

There is urgent need for prompt action to line up the funding needed for investments that will be required well beyond a ten-year time frame. Generating additional and stable transportation funding will allow for investments to be made in major infrastructure projects such as those—transit system extensions, for example, and HOV lane and bicycle network completion—identified in the MTC's 2000 Transportation Blueprint for the 21st Century.

The MTC has determined that \$82 billion in transportation revenue will flow to the Bay Area during the next 25 years, but this amount will not be sufficient to make the investments required. A large percentage of these funds is already dedicated to the maintenance of the current system. Most of the money is already spoken for and committed to specific projects. Therefore, it is necessary to explore increasing state and / or regional gas taxes, extending / introducing county sales taxes initiatives, and lowering the voter-approval threshold to ease the ability of enacting transportation sales tax initiatives.

The above transportation strategies should not, of course, be considered in isolation. They are closely related to residential development, land-use patterns, and environmental concerns. The entire Bay Area, including the Life Sciences cluster, will benefit from thoughtful transportation improvements that are connected with “smart growth” development decisions.

INFORMATION INFRASTRUCTURE

Information infrastructure refers to the information networks running through the Bay Area that allow residents and businesses to communicate with one another by telephone, computer, or other information transfer devices. Well-developed networks are a prerequisite for economic prosperity and growth. They allow for easy and convenient communication between individuals. They make telecommuting for employees a more feasible option. And they provide a foundation from which information-based industries can flourish. It is, therefore, important to the Life Sciences, as to all local industry, that IT networks meet high standards and keep pace with those in other competitive clusters.

STATE OF INFORMATION INFRASTRUCTURE IN THE BAY AREA

The information infrastructure in the Bay Area is very strong. This should occasion no surprise, considering the region’s historical excellence in Information Technology (IT). The area is well served by telephone, cable, and Internet access. Approximately 97% of homes in the Bay Area have telephones, 96% have access to cable TV services, and 61% (the highest percentage in the country) have access to the Internet.³⁶ A recent Bay Area poll indicated that nearly three in ten Bay Area households have high-speed Internet connections. This is nearly double the national average of 15% and underscores the region’s close embrace of IT.³⁷

Overall, the Bay Area is well positioned in terms of its information infrastructure and, as the home of Silicon Valley, is well-positioned at the forefront of new media, technological, and information trends. This will continue to benefit the Life Sciences as remote communication continues to increase in popularity, telecommuting becomes more commonplace, and the use of IT becomes more highly integrated into Life Sciences sub-industries.

PRIORITY ISSUES AND RECOMMENDATIONS

The Bay Area must continue to support projects that work to improve and expand the region’s information infrastructure. This may involve legislative or regulatory change, tax credit introductions, or further research and development funding.

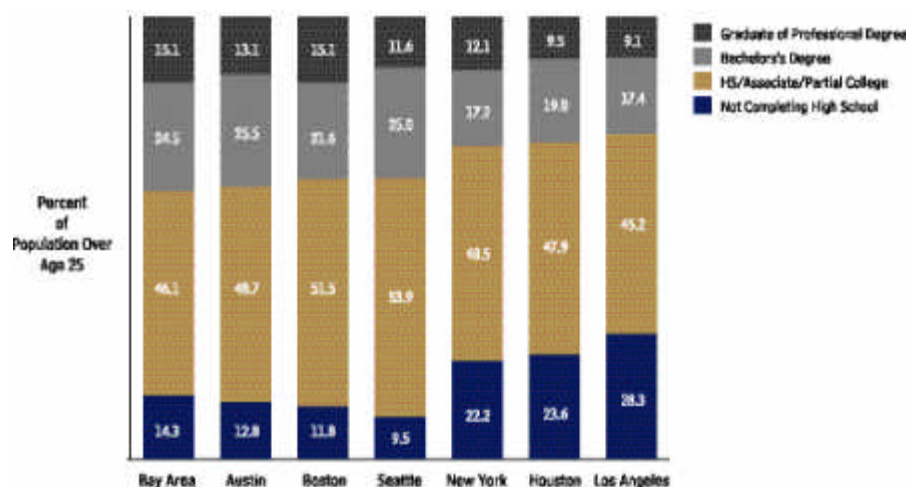
Human capital that has been properly harnessed and leveraged is a critical driver of innovation and growth in every company, every industry, and every region. As a high-technology cluster such as Life Sciences in the Bay Area matures, the sustainability of its competitive advantage is even more dependent on how the region and the companies in it develop and manage their human capital.

For obvious reasons, the Life Sciences are particularly dependent on the availability of highly trained professionals and skilled technicians. Nationwide, 50% of the high-technology workforce has a Bachelors of Science degree, 17% a Masters of Science degree, 19% a Ph.D., and the remaining 14% a degree or diploma from a vocational school or community college.³⁸ According to the Bay Area Clusters of Innovation Survey, Life Sciences executives believe the availability of scientists, engineers, and a skilled workforce is the single most important enabler of business success (Exhibit 10).

STATE OF HUMAN CAPITAL IN THE BAY AREA

The Bay Area currently boasts one of the most highly educated workforces in the country. In 2001, approximately 40% had a college or graduate degree (Exhibit 23). One Life Sciences executive described the Bay Area as an “enormous infrastructure of talent in terms of intellectual capital - smart people! It's collected the best scientists in the world. The universities are continually adding to the new stream of talent who want to live [and work] here.” The region also offers some of the nation's strongest associate

Exhibit 23: Regional Workforce Education Levels



Note: Percent of population over age 25.
Source: U.S. Census 2001 data

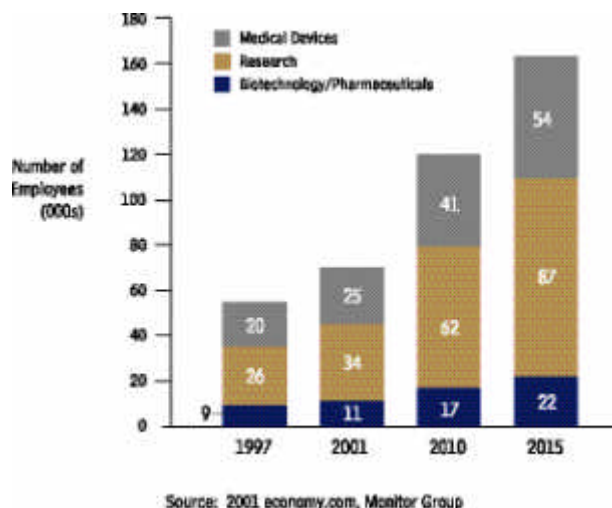
degree and biotechnology certificate programs to meet the needs of Life Sciences companies. There is no question that the economic value of human capital is clearly recognized by Bay Area executives.³⁹

The Life Sciences currently account for more than 80,000 jobs in the Bay Area. Some estimates see that number reaching as high as 120,368 by 2010 (Exhibit 24). For example, in South San Francisco alone, over 70% of companies expect to expand research and development (R&D) operations. No wonder, then, that employment in South San Francisco's Life Sciences cluster is predicted to grow by 1,000 jobs in the next two years.

To date, the cluster has been composed primarily of emerging companies focused on discovery-stage research. However, the fact that across the nation, the cluster currently boasts over 1,400 products in various stages of clinical development (over 400 in late-stage pivotal studies alone), signals that there is a transition afoot. Companies started in the late 1980s and early 1990s that already have products nearing clinical trials and / or commercial manufacturing are now focusing on expanding their product base and manufacturing capacity. Accordingly, they are increasing their investment in internal marketing and sales departments.

All of these areas are expected to see major expansion beginning in the latter part of this decade or the early part of the next (Exhibit 25). Interviews with Bay Area executives have corroborated this. One senior executive summed up the situation in the Bay Area this way: "Traditionally, the Bay Area cluster has been very productive at producing [early R&D] types of people. We now need to be able to recruit more people with expertise in managing clinical trials and marketing strategy."

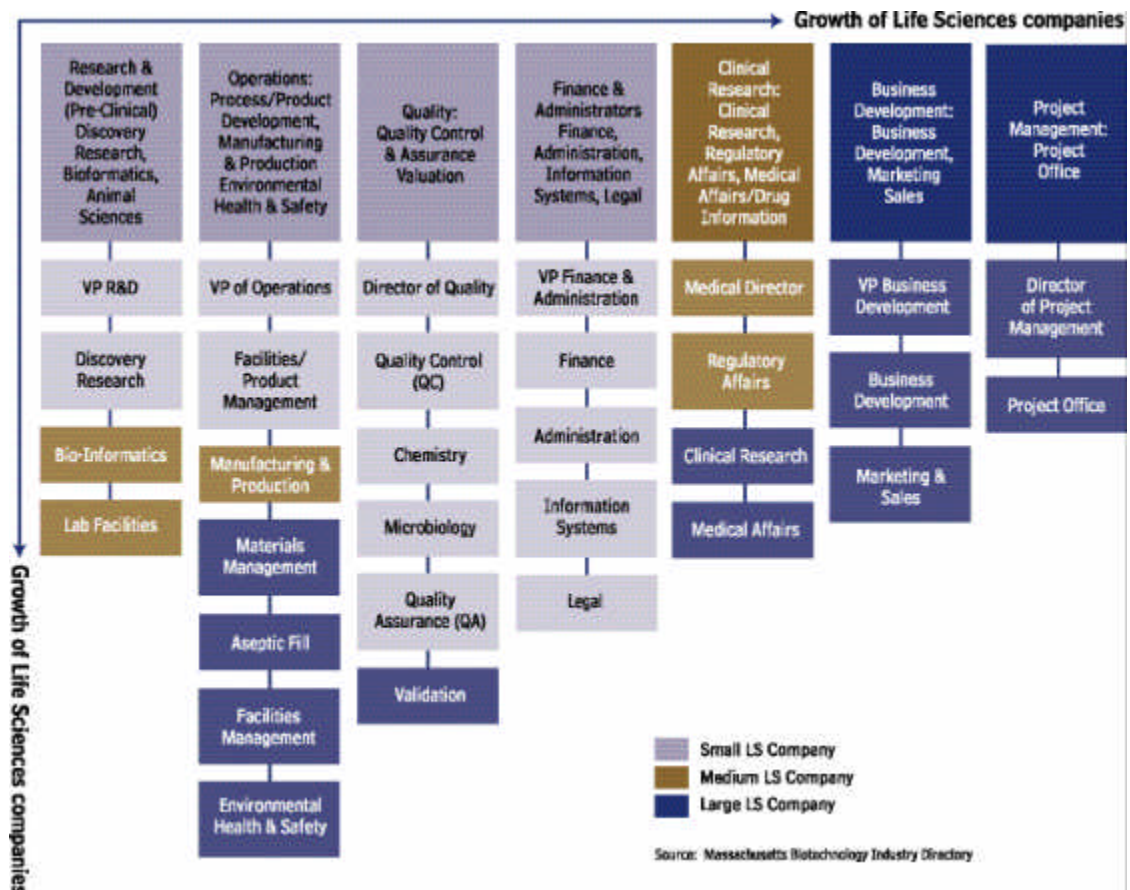
Exhibit 24: Potential Bay Area Life Sciences Employment



The emerging pattern of growth in the Life Sciences suggests that new employment will likely consist of R&D (50%), manufacturing (25%) and commercial, marketing, management and support (25%) positions.⁴⁰ Given the importance of the Life Sciences to the economy of the Bay Area, it is critical for the supply of skilled labor to meet the cluster's burgeoning needs across these functional areas.

As a practical matter, the supply of skilled labor in the Bay Area will include both local and outside talent. Accordingly, the challenges are two-fold: first, re-shape the existing human capital infrastructure to make it more fluid, better trained in relevant content, and better prepared; and second, enhance the region's ability to attract and retain this highly desirable population of world-class talent.

Exhibit 25: Life Sciences Human Resources Needs



Content

There is a widening disconnect between the changing needs of the Life Sciences and the education and preparation of the region's workforce. The region's graduate programs, though excellent, focus on discovery, not on applied or development research, and their faculty are often not in tune with the new "soft skills" and non-science skills desired by Life Sciences companies. In general, what is most lacking is expertise in regulatory affairs, clinical affairs, and quality control (Exhibit 26). Several initiatives—such as the Regional Biotechnology Centers, affiliated with Bio-Link, and Centers for Applied Competitive Technology, affiliated with the community colleges—begin to address these requirements, but they must be expanded, better-coordinated, and more effectively marketed to Life Sciences companies. In addition, there is no grooved, cluster-wide mechanism for continuing education.

Preparedness

The education, with a focus on science and math, offered in the K-12 years must be strengthened to provide a larger pool of students with solid foundations in the Life Sciences so as to boost enrollment in institutions of higher education. California has recently invested nearly \$3 billion to provide students with standards-aligned instructional materials in core curricular areas, including math and science. Recent adoption of state academic content standards in science, together with the alignment of the

statewide testing and accountability system to those standards, could significantly increase focus and boost the quality of science education in California's public schools. The state must monitor the results of these changes closely and build upon these efforts to ensure relevant, strong educational preparation for its K-12 population.

PRIORITY ISSUES AND RECOMMENDATIONS

The pressure on human capital will only grow as Life Sciences activity moves further down the value chain and expands into new technologies. During the next 5-10 years, the most critical needs will be in

Exhibit 26: Critical Human Resource Needs

Level of Importance	Areas of Extreme Need	Department
5.0	FDA Compliance	Regulatory Affairs
4.5	IND, NDA and other regulatory submissions	Regulatory Affairs
4.5	cGMP, GCMP and GLP	Regulatory Affairs
4.2	Clinical, trial, design and modeling	Clinical Affairs
4.1	Technical writing	
4.1	cGMP documentation	Regulatory Affairs
4.1	Process validation	Quality
4.0	Project management	Built into core business center degrees
4.0	Team-based approaches	Quality
4.0	Analytical methods development and validation	Quality
4.0	Materials and document control	Quality
4.0	cGMP training	Regulatory Affairs
3.9	Quality and production	Quality
3.9	Regulatory strategies and negotiation	Regulatory Affairs
3.9	Clinical trials statistical analysis	Clinical Affairs
3.9	Principles of information analysis	Built into core business center degrees
3.8	Clinical data management	Clinical Affairs
4.0	Implementation of clinical trials	Clinical Affairs
4.0	Control systems	
3.9	Clinical trials administration	
3.9	Team-based approaches in biotechnology development & production	
3.9	cGMP audits	Regulatory Affairs
3.9	International regulatory affairs and ISO-9000	Regulatory Affairs
3.8	Systems documentation	Quality

Source: BIOCOM Survey – Biotechnology Company Identification of Areas of Extreme Need

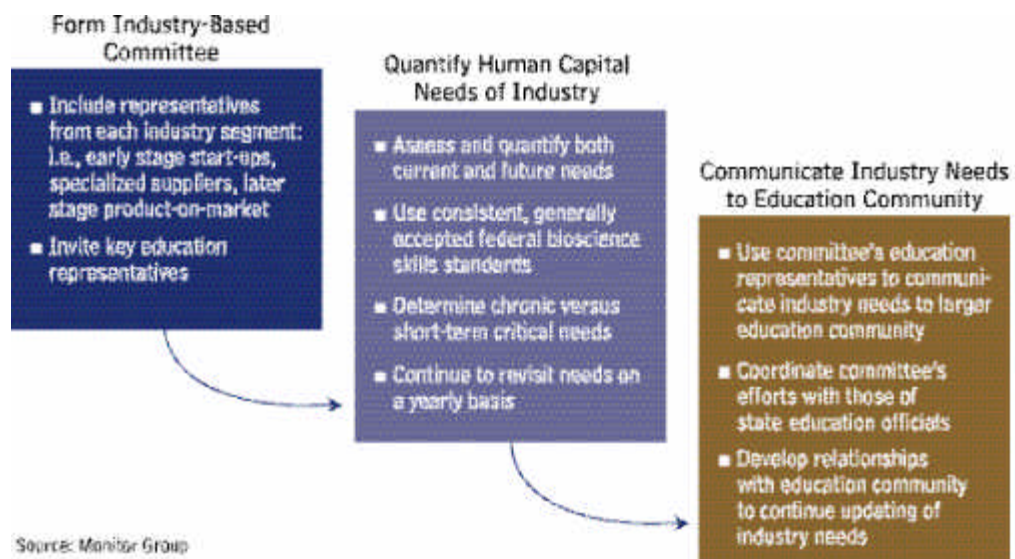
the areas of clinical affairs, regulatory affairs, quality control, and business development (Exhibit 26). Of concern, as well, is the supply of lab technicians to support continued R&D expansion as well as skilled workers to conduct downstream activities such as manufacturing and marketing.

Given the long lead-times inherent in changing a region's human capital equation, the Bay Area should move with speed and urgency to:

Establish and communicate current and future employment needs by skill category in order to drive Bay Area educational and training activity.

To minimize the gap between cluster employment demand and labor supply, there must be a clear articulation of changing needs to all relevant constituencies. In short, the cluster must speak with a single voice and with great consistency in the way it defines skill categories and business needs (Exhibit 27). As a necessary step toward that goal, the cluster must first carry out a qualitative and quantitative workforce gap analysis and then communicate the resultant needs to the education community. This will ensure clarity of definitions as well as a shared fact base from which to establish priorities.

Exhibit 27: Steps to Communicate Industry Needs



Ensure state education officials place greater focus on science education throughout the public education system.

In a recent interview, one Bay Area Life Sciences executive remarked, "What is needed is a central initiative to support the growth and development of the Life Sciences workforce." This is true for all phases of the business cycle from R&D to commercialization and manufacturing. Toward that end, there must be an effort to:

Encourage the California Board of Education Curriculum Commission's Science Subject Matter Committee to meet on a regular basis with the Bay Area Biotechnology Education Consortium and Life Sciences industry leaders.

The Bay Area educational agenda for Life Sciences must recognize that each step in the education / workforce development path can be a driver or a barrier to the success of the Life Sciences cluster. The Science Subject Matter Committee should meet on a regular basis to allow input from the Bay Area Biotechnology Education Consortium and Life Sciences industry thought leaders. It could use the input to set public school system priorities, determine appropriate curricula, and initiate changes at all levels of education. It might also revisit the Life Sciences portion of the Science Standards for California's Public Schools, which was adopted by the California Board of Education in 1998. Though rigorous science standards have been adopted, with textbooks and curriculum frameworks aligned to these standards, these meetings would add yet another dimension to the efforts of the California Board of Education Curriculum Commission's Science Subject Matter Committee, whose current responsibility is to disseminate a Science Curriculum Framework. These efforts could leverage the Biotechnology Education Consortium's mission to develop core curriculum programs and create internship and job placement programs. Further, inclusion of industry thought leaders could ensure relevancy in the classroom.

Create a long-term funding plan to support Bio-Link and its capabilities in Life Sciences workforce preparation.

Bio-Link is a national educational center for biotechnology, which began in late 1998 in the Bay Area with a grant from the National Science Foundation (NSF). Bio-Link has been successful in enhancing and expanding biotechnology education programs in high schools, community colleges, and baccalaureate institutions by providing cutting-edge professional development for instructors, by improving curriculum, by making use of new educational technology, and by creating a system that promotes the sharing of information. Bio-Link and the community colleges are collaborating with industry to develop workforce training programs to meet Life Sciences human resource needs. Despite the success of Bio-Link, its NSF grant funding is scheduled to be cut in half at the end of this year. In August 2004 it will end altogether. Ongoing funding will be necessary if Bio-Link is to continue to address the growing needs of the cluster.

Develop regional, intersegmental training (in particular laboratory) facilities.

The specialized training facilities needed for building essential Life Sciences-related skill sets are currently beyond higher education's funding ability. It makes great sense, therefore, to establish regional training laboratory facilities that cut across the boundary lines of universities, community colleges, and high schools.

Use the digital learning environment to provide continuous education to the current workforce.

On-line continuing education is becoming increasingly widespread as an effective means to leverage the skills and assets of multiple instructional partners. Partnerships could involve educational providers (public and private), industry, and government in developing curricula and encouraging usage of the digital space.

Expand the scope of universities to create a versatile future workforce.

The Bay Area is home to top-tier research universities that graduate large numbers of Ph.D.s each year.⁴¹ The California state university system is often seen as a model for Life Sciences research and workforce development. However, there are a number of critical issues facing the traditional Life Sciences departments in these schools, as they shift toward producing a more versatile pool of students with the ability to drive research in both the academic and corporate worlds.

Experiment with variations in the degrees offered by post-secondary education institutions to ensure relevancy and efficiency.

More than half of recent Life Sciences Ph.D.s find employment in non-academic institutions and bypass the traditional post-doctorate stage. Considering that a Ph.D. requires an average of over 8 years to attain, the Life Sciences would benefit from shorter, faster, more focused, and more industry-responsive degrees, instead of traditional Ph.D.s. Of special appeal would be professional graduate degrees that invoke partnerships between academic institutions and industry.

Experimenting with new degrees also means offering a broader and deeper range of academic options. Graduate programs should allow students to develop a broader portfolio of skills so as to become more versatile scientists. At the same time, there is need for intensive training in new technologies like bioinformatics of critical importance to the Life Sciences of the new century.

Broaden student advisory systems to recognize "alternate career" path.

A number of U.S. National Academy of Sciences studies have, since the mid-90s, emphasized the importance of "alternate careers" in traditional research areas. Companies have new expectations of their future new science and technical employees that include non-science-related knowledge of certain aspects of product development. Academic departments should increasingly be accountable for providing accurate information about professional careers and career advice to students.

Continue to recruit and retain world-class talent.

In California, 9% of the Life Sciences workforce is comprised of H-1B visa holders. Local talent is unable to fill the demand in certain specialized fields. The high figures of foreign employment demonstrate that the existing local talent pool is not sufficient to meet the needs of the Life Sciences and other high-technology industries. In the computer industry, for example, there remain over 260,000 unfilled positions, which costs the industry over \$4.5 billion in lost productivity. Not surprisingly, the presidents of the National Academy of Science and the National Academy of Engineering have emphasized that "the professional 'visits' of foreign scientists and engineers and the training of highly-qualified foreign students are important for maintaining the vitality and quality of the U.S. research enterprise."⁴²

In addition to foreign workers, the Bay Area Life Sciences cluster attracts and recruits talent from other regions and other industries. The government should recognize the integral role that outside talent plays—and will increasingly play—in the Life Sciences, and ensure that public policies do not have negative repercussions on the flow of highly-skilled labor into the region.

Retaining the talent that emerges from Bay Area institutions is critical to the pool of human capital. The state might consider forgiving University of California loans for scientists and engineers who remain in the region to work in Life Sciences.

8 ENTREPRENEURIAL CLIMATE

Entrepreneurial climate refers to an environment that supports the development of entrepreneurial ventures. A successful entrepreneurial climate exists when opportunity (that is, unique ideas and ownership of those ideas) connects with resources (people, capital, and information) and results in successful start-up ventures.

STATE OF ENTREPRENEURIAL CLIMATE IN THE BAY AREA

One of the Bay Area's most competitive assets is a unique environment that fosters innovation and entrepreneurship. As one CEO stated, "The Bay Area is expansive. You think big thoughts here. There are open spaces; you don't feel closed in like on the East Coast. You are encouraged to reach out and try something new." The strength of this entrepreneurial climate is clearly demonstrated by comparing economic indicators. Among the largest 50 metropolitan areas in the U.S., the Bay Area ranks highest in terms of venture capital, number of patents, small but high-growth "gazelle" companies, and initial public offerings (Exhibit 28).

Exhibit 28: Economic Indicators of Entrepreneurial Environment – Rankings of Life Sciences Regions

	Venture Capital	Patents Creation	"Gazelle" Companies	Initial Public Offerings (IPOS)
Bay Area	1	2	4	1
Boston	4	6	42	4
Los Angeles	13	28	12	21
Raleigh-Durham	5	7	48	22
San Diego	7	5	17	7

Source: The Metropolitan New Economy Index, 2001.

This is nothing new. The Bay Area has consistently been a leading region for entrepreneurship and innovation. According to the Progressive Policy Institute, the Bay Area ranks first out of the largest 50 U.S. metropolitan areas in economic / entrepreneurial dynamism across all industries (Exhibit 29). World-class research institutions, venture capitalists, patent attorneys, and experienced senior entrepreneurs all contribute to this special brand of dynamism.

Exhibit 29: U.S. Metropolitan Entrepreneurial Dynamism Ranking

Entrepreneurial Dynamism	Entrepreneurial Dynamism is Ranked According to The Following Criteria:
<ol style="list-style-type: none"> 1. San Francisco 2. Las Vegas 3. Orlando 4. Denver 5. Seattle 6. San Diego 7. Houston 8. Phoenix 9. Austin 10. Atlanta 	<ol style="list-style-type: none"> 1. Number of "gazelle" companies: firms with annual revenue growth of 20% or more for 4 straight years 2. Job Churning: number of new start-ups and business failures within each metro 3. Newly Publicly Traded Companies: The number of companies' initial public stock offerings as a share of gross metropolitan product

Source: The Metropolitan New Economy Index, 2001

Leading Research Institutions

The Bay Area contains some of the world's leading research universities, national laboratories, and private research institutions. This makes the region a center for idea generation. Its leading thinkers interact with one another, exchange ideas, and do much to generate new intellectual capital. It is noteworthy that SRI International and WI Harper have formed a translational drug development initiative, PharmaSTART, to provide California-based university and small company investors with the necessary clinical technical development plans, and other critical support required to bring new drugs to market. Another component of this initiative is to establish the Pan Pacific Life Sciences Fund to finance early-stage Life Sciences companies. The importance of a strong intellectual infrastructure to a region's entrepreneurial climate cannot be overstated. Exhibit 30 on the following page illustrates the spin-off companies from universities in California. Approximately 50% (200 of the 402) of all spin-offs from universities in the state of California come from Bay Area institutions.

Anchor Firms

Also contributing to innovation and entrepreneurship are anchor firms: large biotechnology companies that conduct cutting-edge research. Anchor firms account for a great number of start-ups because they

Exhibit 30: California University Spin-Off Companies

Institution	Biomedical Companies*
Stanford University	94
UC San Diego	63
UC San Francisco	60
UC Berkeley	39
The Scripps Research Institute	33
Caltech	24
UC Davis	18
UC Los Angeles	18
The Salk Institute	16
UC Irvine	9
Lawrence Berkeley/Lawrence Livermore National Labs	7
The Burnham Institute	7
UC Riverside	5
UC Santa Barbara	5
UC Santa Cruz	3
City of Hope	1
Bay Area TOTAL	200
TOTAL	402

Note: Number of biomedical companies founded by faculty or alumni, or based on university technology
Source: CHS Survey, 2001

attract top talent and "entrepreneurial types" to the area and provide valuable training. These recruits often leave the larger firms to pursue their own ventures. This process of "job churning" contributes to the entrepreneurial climate, as well as to the growth prospects of the Life Sciences. A pool of scientists and executives from Genentech, Chiron and Cetus have significantly influenced at least 55 biotechnology firms, research institutions, and VCs. Their alumni have founded, led, or deeply affected such companies as Sugen, Cell Genesys, Deltagen, Genencor, Onyx Pharmaceuticals, and Cell Therapeutics.⁴³

Resources

Opportunity alone is not what makes the Bay Area a top region for start-ups; it is also rich in the

resources needed to grow businesses. It is no coincidence that the Bay Area is the number one region for venture capital (VC) in the world. Venture capitalists prefer to invest locally; the Bay Area receives 30% of VC funding nationally and 80% of VC funding in the state of California.⁴⁴ Because of its technology-driven environment, there is also an abundance of local service providers (i.e. lawyers, consultants, and human resource specialists) who understand and cater to special needs of the Life Sciences.

Connection

It is important to note that while historically strong, the Bay Area's entrepreneurial climate is not without challenges. Although there is a wealth of opportunity in the form of idea generation and intellectual property (IP), and of business resources within the area, many entrepreneurs in the Bay Area still struggle with acquiring those resources. It is difficult for some new entrepreneurs to know where to start when looking for assistance.

According to the Clusters of Innovation Survey, Bay Area participants rated university-based networking organizations as being less helpful to entrepreneurs than did San Diego participants. Other regions have created successful networking programs and have found them to be quite successful.

UCSD Connect is an example of how a networking program can have a profound impact on a regional economy. Companies that participate in UCSD Connect have demonstrated a success rate three times that of other companies. UCSD Connect's mission is to facilitate connectivity within the region as well as between the region and global resources. UCSD Connect has helped bridge the gap between business and science, teaching researchers and professors to become entrepreneurs, and educating the business community about the world of science.⁴⁵

Stanford provides a good example of university-based networking at the private level in the Bay Area with the Stanford Entrepreneurship network. This network creates a forum for collaboration between all entrepreneurship programs at the university, linking the graduate schools of business, medicine, law, and engineering with the office of technology licensing and industry.⁴⁶

PRIORITY ISSUES AND RECOMMENDATIONS

The primary issue surrounding the entrepreneurial climate of the Bay Area is the need to strengthen connection between the IP creators and service provider resources that currently exist. By creating and strengthening networking vehicles in the Life Sciences industry, the Bay Area will further its generation of new technologies and companies.

Expand resource infrastructure for entrepreneurial ventures.

Programs such as the University of California San Francisco's (UCSF) Center for BioEntrepreneurship, a Life Sciences-based program, train scientists and entrepreneurs to develop successful companies. From this program's inception less than two years ago, it has drawn in academic professionals from the Life Sciences research and services industry. It also fosters collaboration between Bay Area universities by opening its programs to them. In addition, the UCSF Center leverages the experience of leading Bay Area industry professionals by pairing them with UCSF's entrepreneurs as team members and mentors.

Another successful approach to teaching scientists about the business of Life Sciences has been UCSF's 11-week course "Idea to IPO and Beyond." The course is designed to show students how to take a basic idea, get it patented, write a business plan, win investment capital, and build a global business. To provide real-world experience, the course features guest speakers who are directors of research, patent attorneys, and finance experts working at many of the most successful Life Sciences companies in the Bay Area.

In addition to expanding these above programs UC-systemwide, a new networking organization that is based on relations rather than transactions should be established. Bay Area leaders have consistently emphasized that people must get to know and trust each other first; deals come later. Any networking organization should host forums that gather entrepreneurs, scientists, business leaders, and investors in a social setting to facilitate communication and present ideas.

Design a centralized web-based resource database.

This would enable entrepreneurs to access specific information on resources located in the Bay Area. The web-based resource database would detail information on funding (VC, angel, and government grants), service providers and non-profit organizations specific to the needs of start-ups. It would also provide information on regulatory policies. Presently, BayBioNEST has plans underway to create such a database.⁴⁷

Leverage proximity to other high tech clusters in Bay Area as a source for new ventures.

Significant convergence is expected between Life Sciences and other industries such as Information Technology. Within the Bay Area, this is recognized in the creation of new centers such as QB3 in Mission Bay. In addition to convergence centers, the Bay Area needs a convergence network across industries. The ideal place to form such a network would be within the research institutions.

TECHNOLOGY COMMERCIALIZATION

9

Cutting-edge research focused on the development of new intellectual property is a primary driver of the innovative spirit and success of competitive regional clusters. Research is, of course, at the heart of innovation. But unless this research can be effectively transferred to the marketplace, the benefit to the regional economy is limited. Technology commercialization is the process of finding, creating, and leveraging—whether through licensing or the creation of new products—intellectual property that has potential commercial applications. Such applications are the fruits of research conducted within a variety of public and private environments, including research universities, research institutions, and established commercial companies (Exhibit 31).

Exhibit 31: Sources of Technology Commercialization Process

Sources of IP	Examples	Description	Commercial Expertise
Research Universities	<ul style="list-style-type: none"> Stanford University of California MIT 	<ul style="list-style-type: none"> Primarily Basic Research Commercial Driven Research 	Medium
Federal, State and Private Research Institutions	<ul style="list-style-type: none"> Lawrence Livermore National Laboratory Lawrence-Berkeley SRI International 	<ul style="list-style-type: none"> Primary Basic Research Participate in Technology licensing Often close ties to research universities 	Medium
Industry Research	<ul style="list-style-type: none"> Genentech Tularik Amgen Pfizer 	<ul style="list-style-type: none"> Strong Commercial Focus Significant interaction with local research universities 	High

STATE OF TECHNOLOGY COMMERCIALIZATION

Research universities, research institutions (federal, state, private), and established Life Sciences companies form the core of the Bay Area's Life Sciences intellectual property (IP) creation mechanism. Private research institutions and established Life Sciences companies generally follow the clearest processes for transferring technology to the marketplace, as this is the explicit mission of these organizations. They have a strong commercial focus and design their research processes to maximize IP creation with commercial value. By contrast, state and federal laboratories often focus resources on basic research or research that

benefits the general research and development (R&D) community as a whole. Although these institutions may have technology licensing functions, such activities are generally not their primary focus.

Research universities present a hybrid model. The Life Sciences research conducted at Bay Area universities mainly focuses on the basic understanding of complex processes and systems. Nonetheless, many of these institutions' research applications—particularly in the field of biotechnology—lie in areas of substantial commercial relevance. Because the explicit mission of these universities is generally not to focus on the commercialization of IP, licensing activities are often not a top priority and potentially valuable IP may not make its way out of the laboratory and into the commercial marketplace. There are opportunities here for improving the rate and efficiency of technology transfer within the cluster. Maximizing great technology transfer by research universities will create opportunities for new start-ups, create additional revenue streams for the universities, transfer new technology into the marketplace, and benefit the regional economy as a whole.

Exhibit 32: Expertise in Technology Commercialization

The technology commercialization process for research universities is shown in Exhibit 33. Federal, state or private research dollars fund the creation of intellectual property potential that results in the licensing of new technology to existing companies or the creation of new start-up establishments. The various constituents involved in the technology commercialization process are:

Research Universities These institutions employ researchers and inventors who produce a supply of inventions and new technology which may hold commercial potential.

Start-up and Existing Companies Companies are the demand side of the technology commercialization equation, finding applications for the inventions produced within research universities.

Venture Capital (VC) Ecosystem The VC Ecosystem is a formal and informal network of operational VCs, local entrepreneurs and angel investors who provides capital and test the commercial viability of new ideas and inventions. The VC Ecosystem provides market-based screening of ideas, pairing of business people with inventors, capital, governance, recruiting and contacts.

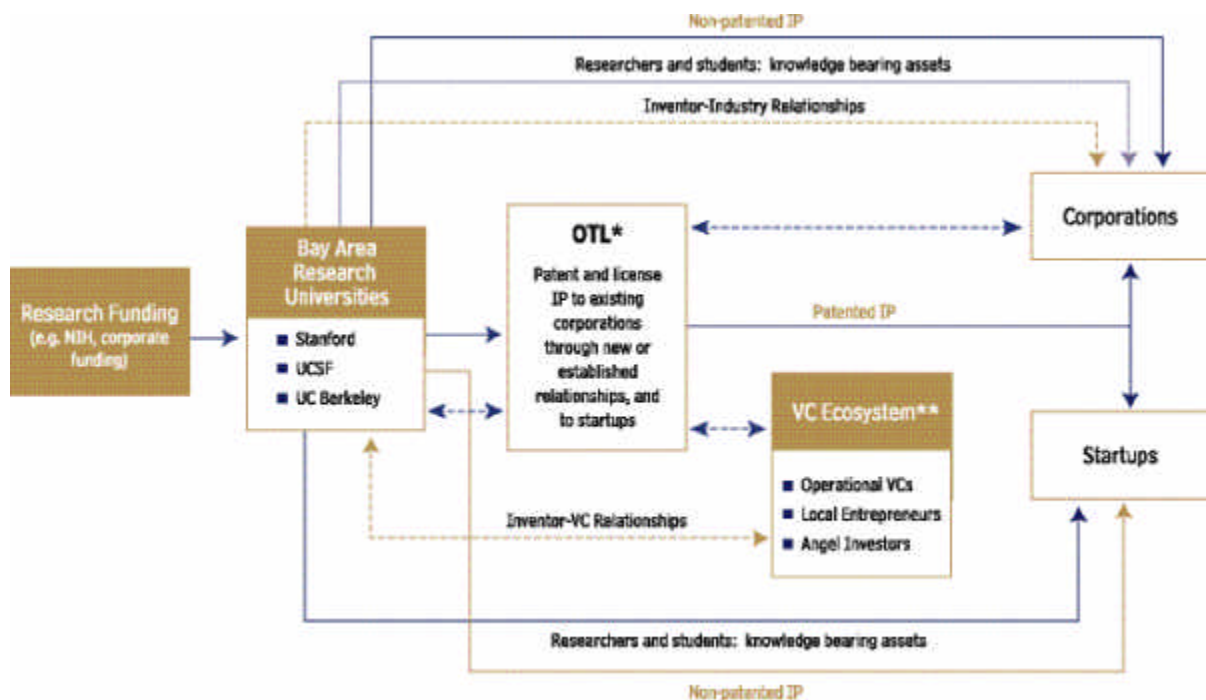
Office of Technology Licensing/Transfer/Commercialization (OTL) University OTLs facilitate the technology transfer process between inventors, companies and the VC Ecosystem. The OTLs' level of involvement depends on the specific deal and nature of previously established relationships.

Graduates of Universities and University Network Research university graduates, faculty and researchers employed as consultants or full-time staff members by regional Life Sciences companies transfer knowledge to the marketplace by bringing their skills and experience to local companies.

These key stakeholder groups work together to identify, value, and commercialize new inventions within the research university environment. The researchers, faculty and students at research universities may be the greatest conduit of technology commercialization. By joining local companies, whether they are startups or established companies, they transfer to the market the knowledge and skills they have acquired and/or developed while at the university. To this end, facilitating the creation of new Life Sciences companies in the Bay Area is a critical component of maintaining the process of technology transfer. To the extent that graduates from local universities choose to relocate to other parts of the country (or the world), technology transfer in the Bay Area is reduced.

Fortunately, technology commercialization—in particular, the transfer of technology from research universities—is a major source of strength for the Bay Area Life Sciences cluster (Exhibit 33). Over time, world-class research institutions in the region have created a significant number of start-up companies and licensed numerous technologies to Bay Area, national, and international companies. The many links, formal and informal, between university researchers, established firms, the venture capital (VC) community, and a vast network of local entrepreneurs and angel investors create a potent – indeed, a unique – nexus of commercialization. Information is quickly disseminated amongst these parties, and new licensing deals are often built upon existing collaborations or relationships.

Exhibit 33: Bay Area Technology Commercialization Process



Note: *Office of Technology Licensing/ Office of Technology Transfer

**Venture Capital Ecosystem provides market-based screening of ideas, pairing of business people with technologists, capital, recruiting and contacts

Source: Monitor Ventures, Monitor Group

Technology transfer in the Bay Area generates substantial value for the regional economy and also benefits the research institutions. Inventors enjoy a flexible and innovative research environment; companies gain access to valuable research; and universities receive substantial financial upside from their licensing activities, as well as from the generous financial gifts made by alumni and faculty who have been successful as entrepreneurs using technology developed at the university. Thus, the schools' Offices of Technology Licensing (OTLs) are best viewed not only as licensing mechanisms, but also as diplomatic entities, which facilitate the transfer of technology for the greater good of the region and which maintain excellent relations with entrepreneurs.

Customer Clarity Regarding University of California Offices of Technology Licensing

The customers (start-ups, existing companies) that create demand for technology commercialization wish to interact with licensing agents that are empowered to negotiate agreements independently. In recent years, the University of California (UC) has addressed this need by creating autonomous branch OTLs at many UC campuses. These branch offices have been increasing their share of cases handled relative to those handled by the central office.

Despite the fact that clear protocols exist for how these offices are allowed to operate, many customers do not understand who has the final authority to negotiate a deal within the UC system. Nor are they always clear about those circumstances in which they must interact with the central Office of Technology Transfer (OTT) office as opposed to branch OTL offices. Further, they sometimes confuse activities overseen by branch OTLs with central legal reviews that must go through a main legal office in Oakland. In aggregate, confusion around roles and decision rights creates hesitation, even avoidance. The solution to this, of course, is better communication about the university process and how to work with it.

Variance in Customer Experience with University of California Offices

Customers consistently mention the varying levels of professionalism they encounter when dealing with the different UC branch OTLs, the central Office of Technology Transfer (OTT), and individual licensing officers. Much of this variation stems from the fact that the UC is not able systematically to hire and retain the people best suited to the job. The licensing of Life Sciences inventions involves a complex set of skills: understanding of the science and, more specifically, its implications; appreciating the way companies operate and what they can and cannot do; and being able to work effectively with inventors, patent lawyers, and company licensing executives. Recruiting people with this skill set is difficult given current university salary levels. Once trained, these people often leave for higher-paying industry jobs.

It is also possible that certain campus OTLs are understaffed. There does not seem to be a formal, shared understanding of what the right level of staffing should be, and some licensing officers carry case-loads that seem unreasonably high.

Lack of Formal Communication Between University Technology Transfer Offices

The various technology commercialization offices of the UC hold formal system-wide meetings on a semi-annual basis. However, they do not regularly communicate or share information with their counterparts at other major universities with significant capabilities in technology transfer, such as Stanford, Caltech, MIT, and Columbia. Given the fairly small number of professionals in this field, cross-university contacts can help foster a more rapid dissemination of best practice learning.

Uncertainty Around University IP Creation Potential

Bay Area universities lack a clear understanding of the IP creation capacity or potential of their researchers and laboratories. Thus, it is not clear if additional outreach, education, and incentives would increase the amount of IP that is offered for commercialization. This is a complex issue. For example, IP that ultimately ends up in the public domain (without the university obtaining patents) through publication or informal dissemination of information as students join local companies may still be effectively “commercialized”. And such commercialization does contribute to the local economy, if not to the university.

A good understanding of the volume of IP that flows through the various channels would be useful so the university could assess the effectiveness of its overall transfer process. In a similar vein, the OTLs do not have an economically-based method for determining the right level of staffing they should have or the right level of resources they should employ to train their current staff and to attract and retain appropriately-skilled new members.

Capital Constraints

Despite the fact that the Bay Area is an international leader in Life Sciences venture capital, all cluster participants agree that there is currently a significant capital shortage for early-stage Life Sciences ventures. The current financial situation limits capital that is available to fund new start-ups based on University technology, which in turn obviously constrains technology transfer.

Access Issues For University Inventors

Finally, because much of the Technology Commercialization process in the Bay Area is built upon informal networks, the technology transfer process can be daunting and intimidating for first-time inventors or faculty who are first time participants. Although informal networks within the Bay Area generally inform companies of available technologies, it is likely that some technology with commercial potential does not get paired with the appropriate business entity because these informal networks fail to reach beyond their established relationships.

PRIORITY ISSUES AND RECOMMENDATIONS

There is clearly much room for improvement in the communication between customers and OTLs, the understanding of full IP creation potential, and current OTL processes.

Direct the California Technology, Trade and Commerce Agency (CTTCA), in collaboration with other regional leadership groups, to work closely with the University of California Office of the President and the Technology Licensing Offices of each University of California campus to develop strategies to accelerate the transfer of technology.

To help build consistently positive customer experience, there must be review both of budgeting mechanisms for OTL branch offices to facilitate the hiring and retention of the most qualified candidates and of staffing levels based on a proper economic analysis of the entire technology transfer process. These initiatives will help the OTLs be competitive with industry norms. Hand-in-hand with improved budgets, and flexibility in hiring and training, the OTLs may consider adopting practices — the use of multifunctional teams as opposed to individual case officers — from other industries that deal with complex projects.

Research University IP creation capacity.

Local universities should conduct formal analyses to better understand the creation and flow of IP involving faculty, researchers, and students. The objective would be to determine where there are points of leverage to increase both the effectiveness and volume of technology transfer. Local OTL offices should be tasked to produce explicit recommendations for or against the procurement of additional staff and the adoption of new IP management-related processes.

Dearth of available capital.

There is a demonstrable need for creative solutions to the demand for capital, given current economic constraints. Programs aimed at reducing the cost of capital for early stage investing (such as matching grant programs, debt-based financing programs, better use of R&D tax credits for pre-revenue companies, lower capital gains taxes for very early-stage investments and the like) would help attract more venture capital to the Bay Area.

Company demand for University IP.

More support is needed for existing networks, both formal and informal, between inventors and industry. This might include OTL outreach programs to the Life Sciences community to better communicate the OTL's capabilities and role within the technology transfer process.

Make the current University of California technology licensing processes more transparent and accessible, while gaining a better direct understanding of industry needs.

Encourage all Offices of Technology Licensing to view themselves as customer service organizations with a complex, long-term mission. This will prevent customers from feeling misinformed about the role of OTLs in relation to other university activities like legal reviews or collaboration agreements. Perhaps the best way for OTLs to gather meaningful metrics of their performance is to survey periodically their constituents—researchers, companies, venture capitalists, and others.

The purpose of such surveys would be to measure performance along a number of key dimensions relevant to the effectiveness of the OTL mission (education and outreach to researchers, marketing and business development to companies, partnering with patent firms, networking and matchmaking with venture capitalists, goodwill ambassadors to alumni and others). These metrics need to be combined with metrics that provide guidelines about actual economic performance based on comparables from other major universities, licensing firms, and companies. The feedback from the surveys should be used regularly to upgrade and improve the operations of the OTLs in a manner consistent with their mission.

Facilitate formal communication between Bay Area Technology Transfer offices.

Directors and Officers from the University of California Offices of Technology Licensing should regularly meet with their counterparts at selected universities with a similar record of technology transfer success—for example, Stanford, Caltech, MIT and Columbia—to share best practices and ensure the cross-fertilization of ideas. In addition, the University of California system may wish to explore a potential rotation program where licensing agents from the central office work with the various branch offices and vice-versa. Later, the University of California system may want to consider coordination with national OTLs or licensing professionals.

Support timely licensing and collaboration deals.

The overriding objective of technology commercialization is to transfer technology into the marketplace for the benefit of the regional economy. Time is often a critical factor in Life Sciences agreements and should be used as an evaluative metric in assessing the performance of the OTLs. In addition to the costly delay in getting ultimate therapies to patients, drugs often have only five years of patent protection by the time they are introduced in the market. A one year delay in the licensing of the core IP can result in a 20% reduction in the royalties a university can earn.

INTELLECTUAL INFRASTRUCTURE 10

Intellectual infrastructure is the research and development (R&D) at the heart of innovation—and technology-based economic development. Many of today's leading technology companies are concentrated around major universities and federal, state, and private institutions performing cutting-edge research.

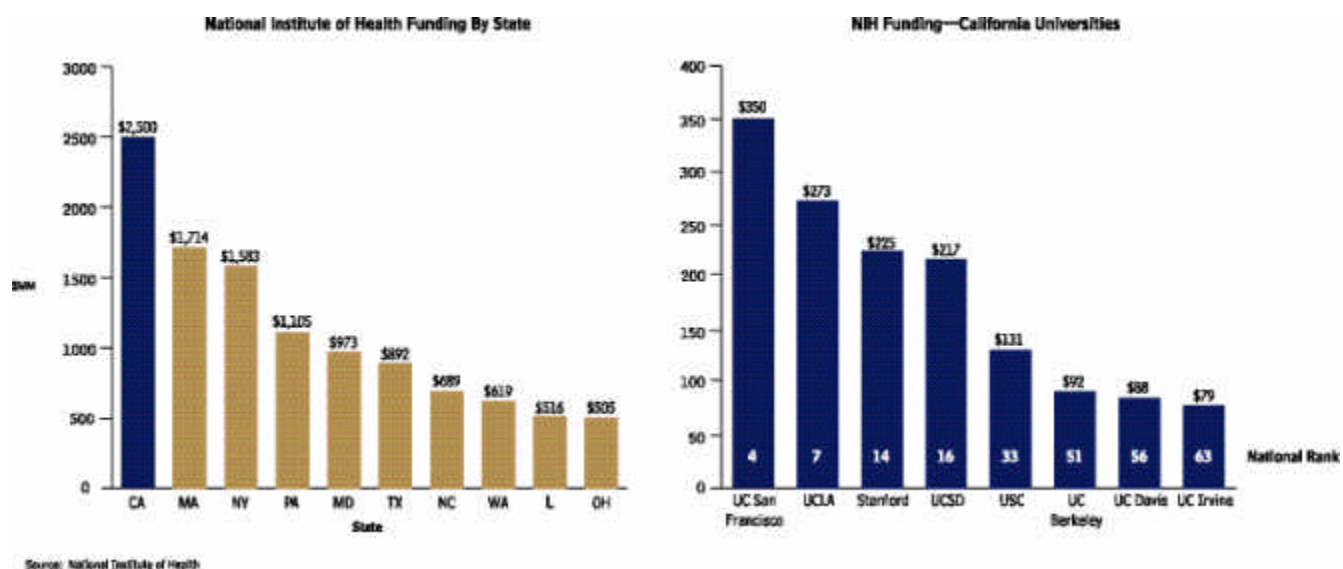
Within Life Sciences clusters, three classes of research and development centers typically contribute to a region's intellectual infrastructure. Research universities form the backbone of successful technology clusters, performing both basic and commercial research. Federal- and state-funded laboratories and private research institutions are additional sources of innovation. These institutions often have strong ties to a region's universities, as is the case with the Universities of California, Lawrence Berkeley Laboratory, and Lawrence Livermore Laboratory. Established companies such as Genentech and Chiron also contribute to the region's research infrastructure and play a strong role in commercializing university technology through collaborations and licensing.

STATE OF INTELLECTUAL INFRASTRUCTURE IN THE BAY AREA

Intellectual infrastructure has long been a source of competitive advantage for the Bay Area Life Sciences cluster and for California as a whole. Cluster stakeholders unanimously recognize the unique value of the region's world-class research universities and its equally strong network of community colleges with programs in the Life Sciences. In 2000, Bay Area research universities dedicated \$908M to research in the Life Sciences, with the majority attributed to Stanford University, University of California, San Francisco (UCSF), and University of California, Berkeley (UC Berkeley).⁴⁸ Most of the region's Life Sciences research (77%) is dedicated to medical research, another 20% to biological research, and 3% to agriculture.

Bay Area research universities have a strong positive impact on the regional economy. This impact is demonstrated through several measures of intellectual infrastructure productivity, including National Institute of Health (NIH) funding, number of Life Sciences graduates, intellectual property creation, and company formation. California is the leading recipient of NIH funding, with \$2.5B in 2001 (Exhibit 34),⁴⁹ approximately 35% of which is concentrated in the Bay Area. By themselves, UCSF, Stanford, and UC Berkeley account for \$670M. The strength of Bay Area research universities is also evident in the number of Life Sciences graduates these institutions produce. In 2000, Bay Area universities produced an estimated 12,000 graduate science, engineering, and health students, of whom 1,400 held specialties in the biological sciences.

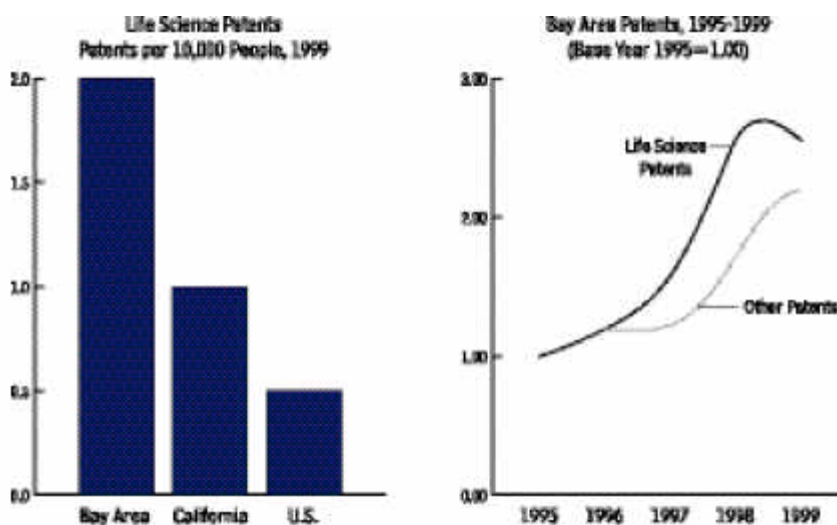
Exhibit 34: National Institute of Health Funding by State and University



Bay Area Life Sciences intellectual property (IP) creation increased dramatically throughout the nineties, resulting in per capita patent production well above both the national average and the average for California as a whole. Experts consistently cite such IP creation (in the form of Life Sciences patents) as a current and future strength of the Bay Area (Exhibit 35).

Finally, the strength of local research universities also has a measurable impact on Life Sciences company creation in the Bay Area. For example, University of California scientists founded at least 35% of Bay Area biotechnology companies, and many more leverage University of California scientific advisors or employ University of California graduates⁵⁰ (Exhibit 36). This proximity of Life Sciences companies to

Exhibit 35: Bay Area Life Sciences Intellectual Property Creation

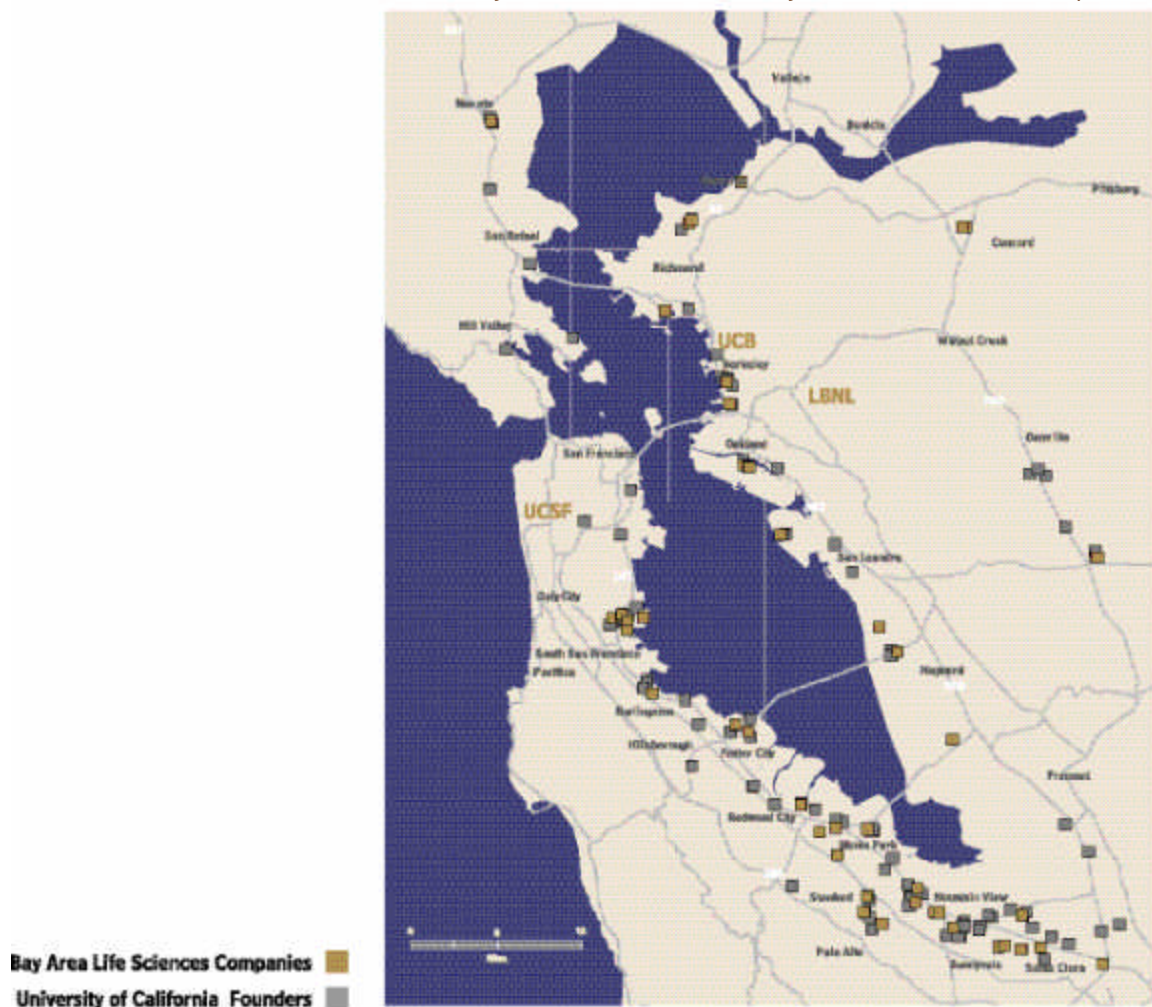


Source: U.S. Patent & Trademark Office. Life Science Patent Classes from Comstock Mellon. Center for Economic Development.

the region's world-class research institutions demonstrates the critical importance of intellectual infrastructure to the continued development of the Bay Area Life Sciences cluster.

In addition to strong research universities, the Bay Area also houses a number of federal, state, and private research institutions. It is home to two of California's new Centers for Science & Innovation. The California Institute for Quantitative Biomedical Research (QB3) builds on the strengths in the engineering and physical sciences at UC Berkeley, the mathematical sciences at UC Santa Cruz, the medical sciences at UCSF, and strong biology programs at all three campuses.⁵¹ The Center for Information Technology Research in the Interest of Society (CITRIS) sponsors collaborative IT research that will ultimately provide solutions to “grand challenge” social and commercial problems.⁵² In addition to these two Bay Area assets, the Centers for Science & Innovation, located outside the Bay Area, also hold promise for California's Life Sciences industry. For example, the California NanoSystems Institute is a joint effort between the University of California at Los Angeles and the University of California at Santa Barbara to facilitate a multidisciplinary approach to develop information, biomedical, and manufacturing technologies.⁵³

Exhibit 36: University of California Links to Bay Area Life Sciences Companies



Note: * Defined as a for-profit business entity with an active R&D operation in California that uses the tools of modern molecular biology (208 total Bay Area biotechnology companies).

** Likely an underestimate due to survey limitations; non-respondent companies are not accounted for.

Source: University of California Industry-University Cooperative Research Program

The Bay Area's research universities, together with federal, state, and private laboratories, form a core infrastructure that supports a strong network of both established and developing Life Sciences companies. These companies often build upon technology invented at local research institutions and develop commercial applications to further this technology. The Bay Area has significant opportunity to build upon its strengths in intellectual infrastructure to ensure that research and innovation remain a competitive strength of the region over the next ten years.

Interaction and Communication Between Universities and Industry

Research university faculty members are generally supportive of collaboration between industry and universities. However, despite an overall strong level of university-industry interaction, some Bay Area faculty members are still suspicious of commercial interests and believe technology commercialization and industry collaboration lie outside the mission of research universities. This bias may limit opportunities for collaboration and technology transfer to the marketplace.

Dedication to High-Quality Laboratory Courses in Undergraduate Education

Despite the strength of Life Sciences programs in Bay Area universities, many cluster stakeholders believe these four-year universities may not provide adequate lab experience to educate undergraduates for immediate employment in the Life Sciences cluster. The lack of commitment to continued funding and investment in additional undergraduate laboratory courses is seen as a potential weakness. This problem is further exacerbated in the K-12 education system, as noted below in Chapter 11. There is a clear disconnect between the quality of the region's research institutions and its upstream K-12 system.

Continued Investment and Vigilance with Respect to Intellectual Infrastructure

In light of convergence between Information Technology and Life Sciences, current success does not guarantee future success. Despite current and planned investments in intellectual infrastructure, some cluster stakeholders fear a future when research institutions may “rest on their laurels” and not aggressively seek to attract the maximum amount of research funding potentially available. Increasing competition from other regions and the dynamic nature of the Life Sciences cluster will require continued vigilance and support for future investment.

PRIORITY ISSUES AND RECOMMENDATIONS

The main issues here are, thus, the gaps in interaction between universities and industry, the availability of and the commitment to funding for laboratory courses, and support for ongoing investment.

Protect and increase investments in the Bay Area Life Sciences intellectual infrastructure, including completion of the California Institute for Quantitative and Biomedical Research (QB3) and the Life Sciences research park at NASA Ames.

Support completion of the California Institute for Quantitative and Biomedical Research (QB3/ Mission Bay) and the California NanoSystems Institute and sustain investment in the Life Sciences research park already underway at NASA Ames. In addition, explore future opportunities to develop additional infrastructure to ensure that the Bay Area retains its competitive edge, paying special attention to areas of convergence, such as bioinformatics—that is, the intersection of Information Technology and the Life Sciences.

Utilize adjunct professorships and sponsored forums to enhance communication.

Stanford, the Universities of California, and other Bay Area institutions should actively assess the role adjunct professorships play in fostering communication between universities and industry. Increasing the number of adjunct professorships could provide more formal channels for industry leaders to share knowledge with students and faculty. Some cluster stakeholders feel that universities currently have a “keep them at a distance” attitude towards adjunct appointments. Instead, the Governor and state education officials should encourage universities to offer more adjunct professorships to encourage flows of information.

Strengthen corporate/university relationships and networks.

Explore opportunities to create biotechnology fellowships for post-doctoral students like those offered by pharmaceutical companies. In general, test the mindset within research universities with respect to industry and commercialization as a foundation for assessing the measures by which existing biases against commercial activities can be removed.

Foster laboratory capital development.

Support current and future investments in infrastructure for additional laboratory courses in high school and higher education.

Simplify mechanisms for cross-university course registration.

Bay Area research universities should assess the possibility of cross-campus course enrollment, thus allowing students at one Bay Area campus to have access to courses at all others. Cluster stakeholders note the model followed in Boston among MIT, Harvard, and other nearby universities as a best practice in cross-university course selection.

II QUALITY OF LIFE

The quality of life in a region is an aggregate measure of many different criteria. A study conducted by William M. Mercer, based on an evaluation of 39 quality of life criteria (among them: political and social environment, economic environment, socio-cultural environment, medical and health considerations, schools and education, public services and transportation, recreation, consumer goods, housing, and the natural environment), named San Francisco as one of the top 20 cities in the world in which to live.

The attractiveness of the region is a key concern for all Bay Area industries. It greatly affects every company's ability to attract employees, and it deeply influences executives' decisions to locate in the region. In the Clusters of Innovation Survey, 48% of Bay Area respondents indicated that overall quality of life for employees was one of the elements that currently has the greatest positive impact on their business success (Exhibit 10). However, 42% of respondents also indicated that, during the next five years, they expected quality of life for employees to be one of the most serious barriers to their firms' expansion in the region (Appendix D, Exhibit 42). It is clearly in the best interest of the Life Sciences cluster that the Bay Area preserve and strengthen its overall quality of life.

STATE OF QUALITY OF LIFE IN THE BAY AREA

The Bay Area is renowned for its attractive climate, scenic landscapes, proximity to recreational activities, rich cultural offerings, and diverse population—all of which make it a highly attractive region in which to live and work. Unfortunately, the area is also known for its high cost of living, increasing traffic congestion, and unequal K-12 education quality.

Climate

The Bay Area's temperate climate is often cited as one of regions best qualities. On average, the area has an average temperature of 63°F (18°C), 309 days of sunshine each year, and annual rainfall of approximately 20 inches.

Recreation

The scenic beauty of the region also adds much to its appeal. The nine Bay Area counties have roughly 150 significant parks with about 7,500 miles of trails.⁵⁴ Proximity to mountains, forests, and ocean provides an ideal setting for outdoor activity. Whether the choice is golf or sailing, kayaking or skiing, the region

has much to offer. In addition, the Bay Area is home to eight professional sports teams. On the collegiate sports level, four Bay Area universities consistently field nationally-ranked football, basketball, baseball, and soccer teams, strengthening a spectator and outdoor sports culture that few U.S. cities can match.

Culture

CNN Money recently ranked San Francisco as the fourth best city in terms of art and culture in the U.S. The Bay Area houses more than 37 museums dedicated to art, science, culture, ethnicity, and history, providing a diverse set of cultural experiences. In addition to the variety of museums, San Francisco is also one of only a few cities in the world with internationally-recognized resident companies in all of the major performing arts—opera, symphony, ballet, and theater. Hundreds of restaurants, cafes, and night-clubs have also brought San Francisco and the surrounding cities an international reputation as a center for culinary supremacy and musical entertainment.

Diversity

The richness of cultural activities in the Bay Area is matched by the diversity of ethnic cultures. With more than 140 languages spoken in the region, the Bay Area houses one of the most ethnically and linguistically diverse populations in the world. The largest ethnic group is Mexican / Latino, which is bolstered by Chinese, Filipino, Vietnamese, and Laotian communities, the size of whose area populations is second only to that of their native countries.

Just as the Bay Area has unique strengths in quality of life, it also has unique challenges. The region's high cost of living, poor public transportation system, and uneven delivery of K-12 education detract significantly from its other advantages.

Cost of Living

Despite being stable throughout most of the 1990s, the cost of living in the Bay Area has risen considerably since 1998. Indeed, it has risen so much that the San Francisco metro area overtook New York in the third quarter of 2002 to top the list of the ACCRA Cost of Living Index as the most expensive large U.S. city. The cost of a professional / managerial standard of living is 84.1% above the average of over 300 urban areas across the U.S. (Exhibit 37 on the following page).

Although major cities tend to be expensive, the Bay Area stands out primarily due to its cost of housing. This is particularly evident in Exhibit 37. High demand for a limited number of homes in the region has driven prices extremely high. This issue is addressed in greater detail in Chapter 5. Suffice it to say here that action must be taken to provide more affordable housing if the Bay Area is to compete successfully against other regional clusters in attracting and retaining employees.

Transportation

Bay Area residents have to deal with increasing traffic congestion and a poorly coordinated transit system. In fact, local residents see transportation as such a problem that, in every year since 1980, respondents to the *Bay Area Poll* conducted by the Bay Area Council have identified transportation as one of the top three problems in the region. In 15 of those years, transportation ranked as the number one concern. Fully 88% of Bay Area residents agree that worsening traffic congestion is seriously threatening their quality of life.⁵⁶

Exhibit 37: ACCRA Third Quarter 2002 Cost of Living

Metropolitan Area	Cost of Living Composite	Grocery Items	Housing	Utilities	Transportation	Health Care	Misc. Goods and Services
San Francisco, CA PMSA	184.1	141.1	332.7	92.4	130.0	143.8	123.7
New York, NY PMSA ¹	175.1	132.8	289.1	143.7	117.2	148.2	128.2
Newark, NJ PMSA	148.3	118.4	214.7	137.1	113.4	158.1	118.2
Seattle – Bellevue – Everett WA PMSA	148.2	116.0	228.2	123.3	111.5	160.3	111.2
Oakland, CA PMSA	139.5	130.1	203.8	100.5	120.6	139.6	140.6
San Diego, CA MSA	137.8	125.4	194.8	79.8	121.9	133.3	115.1
Chicago, IL PMSA	135.7	119.7	185.5	116.6	120.7	135.4	110.3
Boston, MA–NH PMSA ²	135.5	114.8	177.3	153.9	106.4	134.8	114.6
Nassau – Suffolk, NY PMSA	135.3	121.2	174.1	127.0	112.4	140.6	117.5
Los Angeles – Long Beach, CA PMSA	135.2	109.6	199.1	110.6	112.9	111.1	109.6

Note: ¹Unweighted average of New York (Manhattan and Queens); ²Unweighted average of Boston Massachusetts section only. Index measures relative price levels for consumer goods and services in over 300 participating areas. The average for all participating places in each quarter equals 100, and each participant's index is read as a percentage of the average for all participating places. The index does not take taxes into consideration. The weights assigned to each item in the index come from the Consumer Expenditures Survey conducted by U.S. Bureau of Labor Statistics.

Source: ACCRA

Education

K-12 education is also a serious concern. In the *Bay Area Poll* conducted by the Bay Area Council, 85% of respondents indicated that improving public education was very important to them, and a significant number of respondents remain dissatisfied with public education in the Bay Area.⁵⁷ This perception of educational performance could undermine the Bay Area's economy by encouraging workers and their families to locate elsewhere and by failing to produce the skilled workforce needed to sustain productivity.

Although the Bay Area leads California in K-12 education, certain public schools—particularly those in low-performing districts—have been unable to recruit and retain an adequate number of teachers. Education quality suffers in part due to the severe shortage of qualified, experienced teachers.

PRIORITY ISSUES AND RECOMMENDATIONS

Despite these challenges, people continue to flock to the region. Once they arrive, they tend to stay. Quality of life continues to stand out as one the Bay Area's unique strengths. However, to preserve this strength and enrich this strength, there must be improvements in the cost of living, the ease of transportation, and the quality of K-12 education.

Some aspects of the region's quality of life—climate, for example—are intrinsic to the region's quality of life. Others require active, thoughtful support from governments, regional and local agencies, and busi-

nesses. It will take purposeful action to protect the region's environment, its parks and open spaces, its art and cultural activities, and the special needs of its richly diverse population.

Recommendations on issues related to cost of living and transportation are covered in Chapters 5 and 6. What follows are suggestions for improving K-12 education in the Bay Area.

Improve the overall K-12 public school system by continuing to support state and regional initiatives.

In addition to increased pay, professional and educational development for the K-12 public school workforce is key to ensuring high performance of the public school system. Governor Davis and the California Legislature have initiated and actively supported multiple programs to address the recruitment, preparation, and professional development of the K-12 teaching and administrative workforce. The state must continue to support these initiatives, expand upon the most successful ones, and make alterations where necessary to ensure that California's education system is improved.

Addressing education standards in the state and, more specifically, in the Bay Area is imperative if the region hopes to attract employees, especially those with young families. Life Sciences leaders have highlighted education as a particular problem in recruiting people to fill middle management positions. Respondents to the Clusters of Innovation Survey believe that it is critically important for government to promote world-class education to help increase innovation in the region (Appendix D, Exhibit 44). Active advocacy to ensure that changes take place in the near term is critical.

Ensure teachers' pay is in line with the rising cost of living.

Public school teachers' pay, especially in large cities, has failed to keep pace with comparable wages in the private sector. Although teachers' salaries grew 36.5% from 1990-91 to 2000-01, annual earnings for all workers in the nation grew by 45.9% during the same period.⁵⁸ After adjusting for the cost of living, Bay Area teacher salaries rank among the lowest across the country (Exhibit 38).

Although the Bay Area has some of the highest performing schools in the state and nation, the challenge is to improve performance of all schools. A study conducted in 2001 determined that "...school staffing problems are primarily due to excess demand resulting from the 'revolving door' where large numbers of teachers depart their jobs for reasons other than retirement." The study went on to conclude that "improvements in organizational conditions, such as increased salaries ... would all contribute to lower rates of turnover, thus diminish school staffing problems, and ultimately aid the performance of schools. One crucial part of the solution is better pay for quality teaching."⁵⁹

Exhibit 38: Comparative Teacher Salaries

California City	Cost-of-Living Adjusted Teacher Salary	Rank Among 100 Largest US Cities
Fremont	\$39,783	92
San Francisco	\$38,155	94
Oakland	\$33,328	98
San Jose	\$33,036	99

Source: American Federation of Teachers, October 2001

12 A CLUSTER VOICE

This Strategic Action Plan represents the collective thinking of the broad set of constituencies that comprise the Bay Area Life Sciences cluster. Through surveys, interviews, discussion fora, and the Bay Area Life Sciences Summit, the cluster has come together to identify the critical obstacles to its further expansion in the Bay Area and to recommend a broad range of actions to remove those obstacles.

This is the first time that the entire Bay Area Life Sciences cluster has conducted an exercise of this nature. The motivation: to address the concern, expressed by many of the participants, that without some formal mechanism, their collective voice may not be heard. This kind of silence is simply not tolerable. Too much is at stake. Going forward, to ensure its continued global leadership and guarantee that its voice is heard and heard clearly, the Bay Area Life Sciences cluster must mobilize behind a strong and active, non-governmental Life Sciences collaborative organization with sufficient resources to develop and manage a robust and aggressive plan.

The principal goals of such an organization would be to:

- Increase public awareness and support for the Life Sciences as a driver of the regional economy and a significant contributor to improved quality of life.
- Develop and implement strategies to attract and retain Life Sciences companies and activities in the Bay Area.
- Serve as an advocate to policy makers and civic leaders on behalf of the cluster in order to promote and advance Life Sciences issues in the region.

Bay Area Bioscience Center

The Bay Area Bioscience Center (BayBio), established in 1990 by the Bay Area Economic Forum, a partnership between the Bay Area Council and the Association of Bay Area Governments, has been the primary organized voice and forum for the Life Sciences cluster in the region. To date, BayBio has done the pioneering work in convening the cluster and has provided the principal mechanism for articulating its voice on public policy. However, BayBio is currently modestly funded and, therefore, has limited capacity to operate at the level needed to optimize impact. In order to realize the full potential of Life Sciences in the Bay Area and in California, there must be a quantum increase in the resources and energy dedicated to strategically promoting and growing the cluster.

The Life Sciences non-governmental organization recommended in this Strategic Action Plan must build upon the work of BayBio. Further, BayBio should be a central player in determining how best to organize and fund the organization so envisioned. In fact, one option for the new non-governmental organization may be a strengthened and enhanced BayBio. However, the status quo and business as usual are not acceptable. The other partner organizations involved in the Bay Area Life Sciences Summit and in the preparation of this Strategic Action Plan also must work together to design and launch this next generation non-governmental collaborative “voice of industry” organization. That is the only way to ensure that the Bay Area can successfully compete in the future as a premier region for Life Sciences.

This group would provide a backbone for the Life Sciences cluster and support for cluster-specific initiatives in the future. It would also be an active partner in the implementation of the recommendations included in this Strategic Action Plan.

A “Best Practices” Example

BIOCOM in San Diego is an example of a highly effective regional Life Sciences organization. BIOCOM's mission is to promote the growth of all sectors of the cluster through the creation of member value in the areas of public policy, member services, education, and business networking. Members include more than 50% of the Life Sciences companies in San Diego, as well as service providers, non-profit associations, government agencies, and research institutions. BIOCOM has a \$4 million annual budget and a staff of 15 full-time employees. It is funded through membership dues, events, and a for-profit purchasing group.

The Support of Government

Government at all levels can show support for and work with non-governmental organizations. To amplify the efforts of the Bay Area Life Sciences cluster non-governmental organization, state, regional and local governments can:

Mobilize political jurisdictions behind marketing the Bay Area as the best region in the world for Life Sciences.

A Cluster Voice

The Life Sciences cluster in the Bay Area plays a critical regional role as customer to many businesses, as partner in innovation to multiple industries, as creator of the livelihood for many in the region's workforce, and as contributor to the regional economy. Equally important, as developer of innovative therapeutics and as researcher on the cutting-edge of beneficial products, it plays an ever more important role in the well-being of all humankind. Such a cluster must have its thoughts and needs voiced through a powerful channel that reflects the unquestioned value of the region's Life Sciences. Such a voice will enable the Life Sciences to grow, to flourish, to bring prosperity to the region, and to improve the health of people all over the world.

THE STRATEGIC PLANNING PROCESS

appendix a

In the fall of 2002, a working team, consisting of the Bay Area Council, the Office of the Governor of California, the California Technology, Trade and Commerce Agency, the Bay Area Bioscience Center, and the Monitor Group, was established to develop the Bay Area Life Sciences Strategic Action Plan. Each of these organizations played a key role in contributing to the content of the Strategic Action Plan and in facilitating access to a broader set of participants.

The working team employed the Clusters of Innovation theory as a basis for framing its critical choices. This framework, which is described in greater detail in **Appendix C**, was used as a guide for defining the Bay Area Life Sciences cluster and for structuring choices such as those relating to prioritizing investments, allocating resources, and planning for growth.

After establishing the framework, the working team took a number of measures to inform itself about the critical choices outlined in the Strategic Action Plan. In addition to assessing currently available data, including an assessment of strategic Life Sciences reports that had been previously developed for competitive regions (**Appendix B** has a comprehensive list of such reports), the working team pursued a number of avenues to secure the insights of the Bay Area's and, where appropriate, other key constituencies. Most notably, the Monitor Group conducted 59 in-depth interviews with key stakeholders from Bay Area companies, government, universities, and other institutions; administered an online survey; and jointly sponsored with the working team a Life Sciences Summit held on December 3, 2002, entitled "Promoting the Life Sciences, New Initiatives for the Bay Area".

The Clusters of Innovation Regional Survey is a comprehensive diagnostic tool used to assess the competitiveness of a particular region's local business environment. The San Francisco Regional Governor's office sent the web-based survey via e-mail to Life Sciences cluster constituents in the nine Bay Area counties. Previously, the survey had been administered to several regions throughout the nation. The objective of the Bay Area survey was twofold. First, quantifiable data was collected to supplement the qualitative interview data collected on the climate for Life Sciences in the Bay Area. Second, the Bay Area regional business environment was benchmarked against that of other competitive Life Sciences cluster regions. The resultant data was used to examine the Bay Area's current competitive positioning and to identify the key issues to be addressed in the future. Survey results may be found in **Appendix D**.

As another vehicle for collecting ideas, one-on-one interviews took place with executives of leading Life Sciences companies, members of research institutions, and influential supporting-industry

stakeholders. The Monitor Group conducted 59 such interviews with individuals from each of the constituencies of the Life Sciences cluster. Twenty-six interviews were conducted with the objective both of framing the critical choices and generating the hypotheses underlying the Strategic Action Plan and of developing the content for the Summit. Thirty-three interviews tested and refined the hypotheses generated by the breakout sessions at the Summit.

The Life Sciences Summit brought together government officials, industry leaders, academic representatives, and other key stakeholders. Participants met in small breakout sessions to discuss critical issues and action ideas relevant to the Life Sciences in the Bay Area. Ideas from the Summit served to inform the Strategic Action Plan.

SELECTED SOURCES

appendix b

A Critical Analysis of the Local Biotechnology Industry Cluster in Alameda, Contra Costa, and Solano Counties

Economic Development Alliance for Business

Bay Area Bioscience Center

Bay Area Economic Profile

After the Bubble: Sustaining Economic Prosperity, January 2002

Bay Area Council

Bay Area Economic Forum

Association of Bay Area Governments

California's Bioscience Industries: Overview and Policy Issues

Assemblymember Howard Wayne, Chair of the Assembly Select Committee on Biotechnology

Clusters of Innovation: Regional Foundations of U.S. Competitiveness

Michael E. Porter

The Monitor Group

Council on Competitiveness

Israeli Biotechnology Strategy Project: Realizing our Potential

The Monitor Group

MassBiotech 2010: Achieving Global Leadership in the Life Sciences Economy

Massachusetts Biotechnology Council

Preparing for the Next Silicon Valley: Opportunities and Choices

Joint Ventures: Silicon Valley Network

Projections 2002: Silicon Valley

Silicon Valley Manufacturing Group

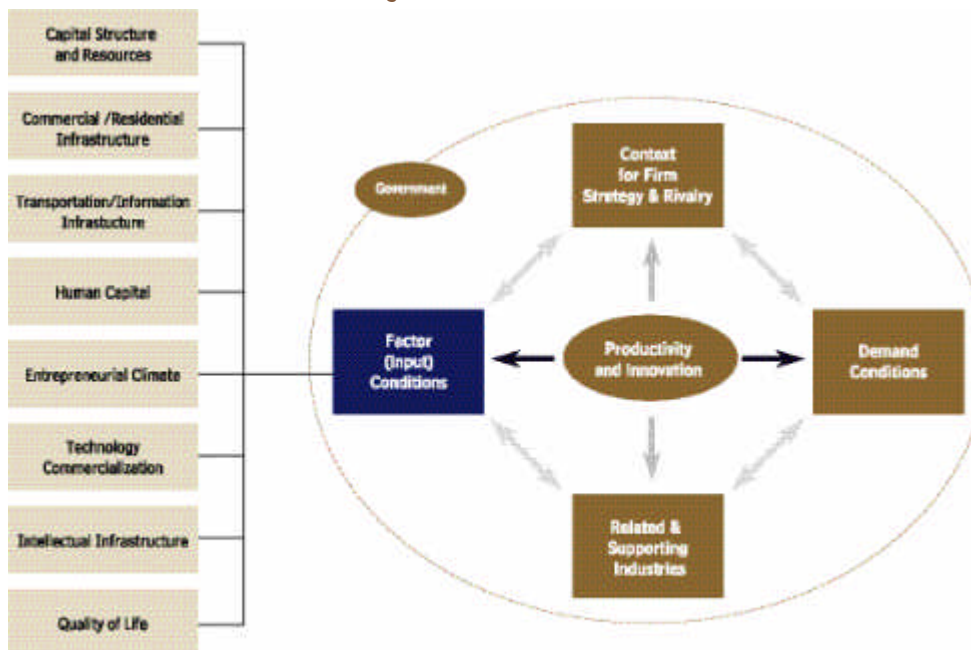
CLUSTERS OF INNOVATION THEORY

appendix c

The working team employed the Clusters of Innovation theory as a basis for defining the Bay Area Life Sciences cluster and for structuring such choices as those relating to prioritizing investments, allocating resources, and planning for growth. In addition, the working team drew on learnings derived from the Monitor Group's experience in the area of regional competitiveness. It leveraged the knowledge of the participants on the working team regarding the development and evolution of industry clusters and the forms of intervention that positively and negatively influence them.

Conventional thinking places clear boundaries between industries and focuses exclusively on an industry's internal structure and dynamics as the space for competitive advantage. Cluster thinking does not disregard the relevance of the "inside" of an industry, but broadens the terrain for competitive advantage to capture cross-industry linkages. The broader cluster approach to Life Sciences recognizes and places value on the cross-industry interactions among multiple constituencies in Life Sciences cluster, its inputs, related industries, buyers, and government.

Exhibit 39: Determinants of a Regional Business Environment



Source: Clusters of Innovation: Michael Porter, Monitor Group, Harvard Business School, Council on Competitiveness

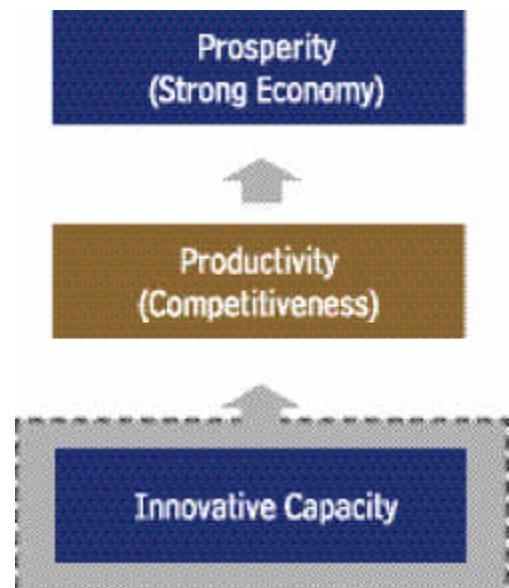
The broad perspective enabled by the idea of clusters permits a comprehensive understanding of the prosperity of a region. At a high level, prosperity depends on a region's ability to create a business environment that fosters innovation and productivity (Exhibit 40). Strong, competitive clusters are a critical component of a good business environment and are the driving force behind regional innovation and rising productivity. Clusters allow companies to operate more productively in sourcing inputs, accessing information, technology and needed institutions, coordinating with related companies, and measuring and motivating improvement. Clusters allow each member to benefit as if it had greater scale or as if it had joined others without sacrificing autonomy.

Cluster theory implies that the four key determinants of a region's business environment must be considered as the region plans for its future success. However, it is important to note that the theory recognizes the unique nature of each cluster. Thus, the four determinants have differing degrees of relevance depending on the cluster and region in question.

In the Life Sciences cluster, the primary determinant of the regional business environment is factor or input conditions (Exhibit 39). The quality of specialized inputs and related conditions in the Bay Area are particularly important to the success of the Life Sciences. These factors include: Capital Structure and Resources, Commercial and Residential Infrastructure, Transportation and Information Infrastructure, Human Capital, Entrepreneurial Climate, Technology Commercialization, Intellectual Infrastructure, and Quality of Life.

The additional determinants are the Context for Firm Strategy and Rivalry, Demand Conditions, and Related and Supporting Industries. Context for firm strategy and rivalry refers to the "rules, incentives, and pressures governing the competition in a region." The presence of rivals creates healthy competition between local firms. The quality of demand conditions has "a strong influence on the process of creating and improving products and services." These demand conditions are present to the extent that sophisticated local customers create an efficient feedback mechanism to catalyze innovation. Related and supporting local industries stimulate the efficient communication and flow of ideas within and across clusters. The Bay Area Life Sciences cluster overlap with the Information Technology cluster is a perfect example.

Exhibit 40: Prosperity Chain

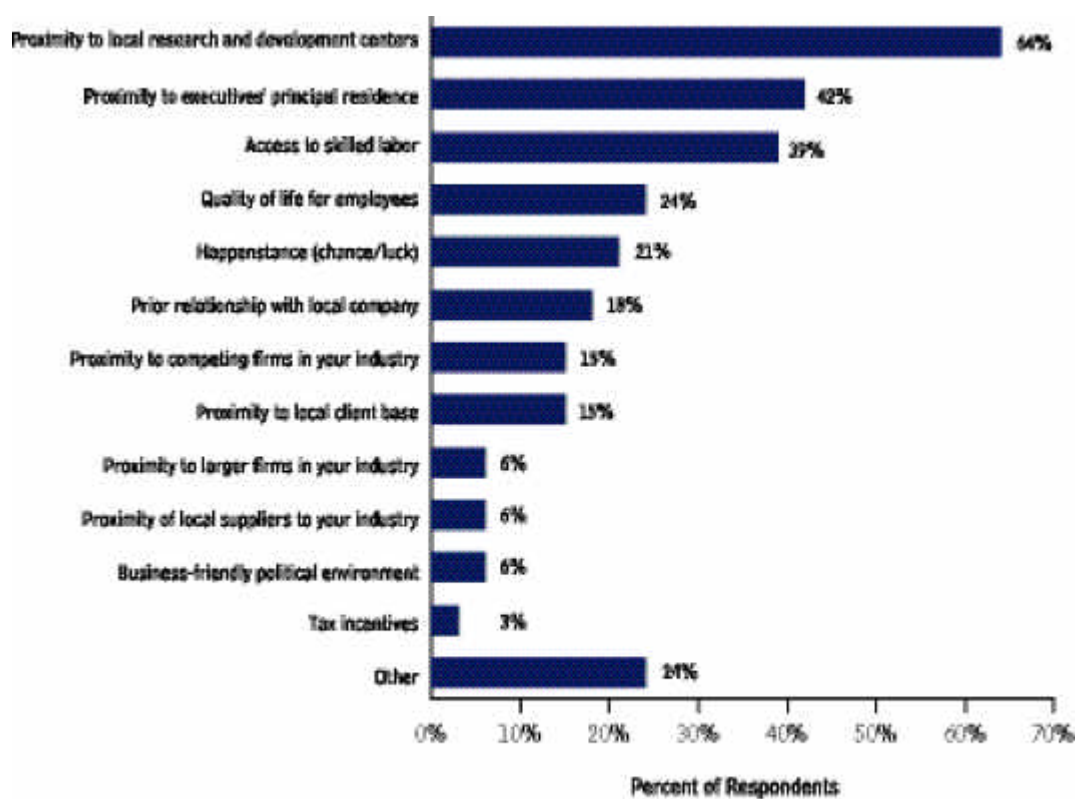


CLUSTERS OF INNOVATION: QUANTITATIVE SURVEY DATA

appendix d

Exhibit 41: Firm Location Factors

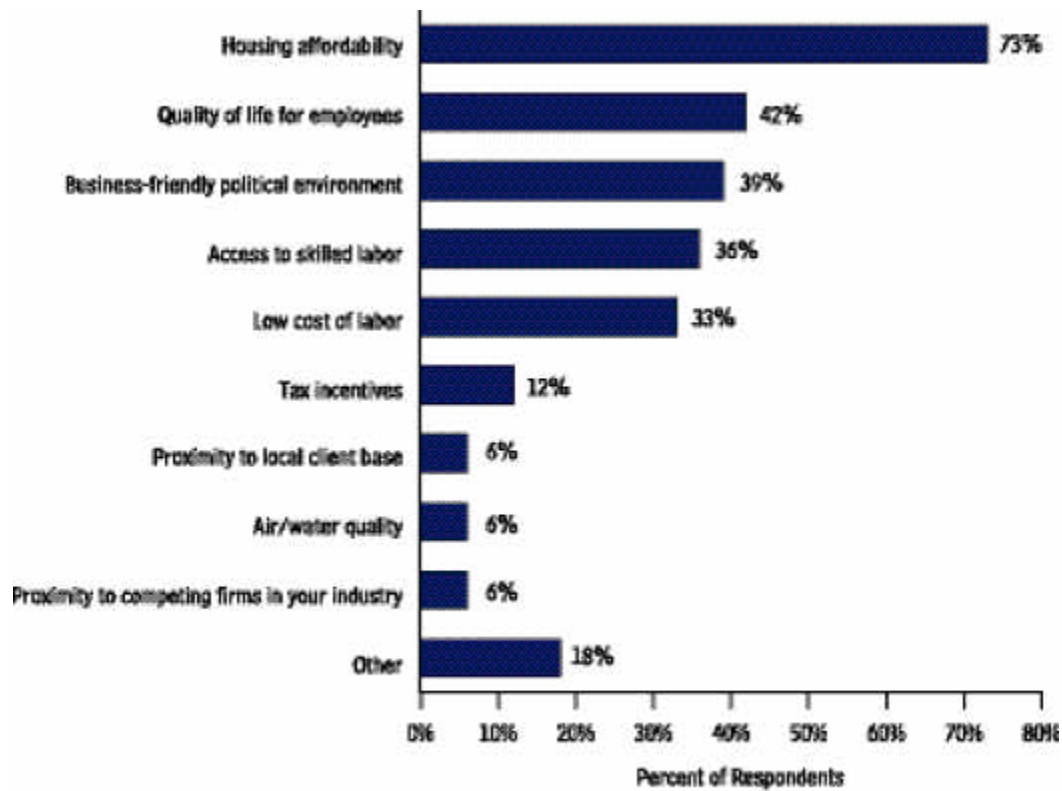
Currently, what are the most important reasons your firm is located in the Bay Area?



Source: Bay Area Clusters of Innovation Quantitative Survey, 2002

Exhibit 42: Barriers to Firm Expansion

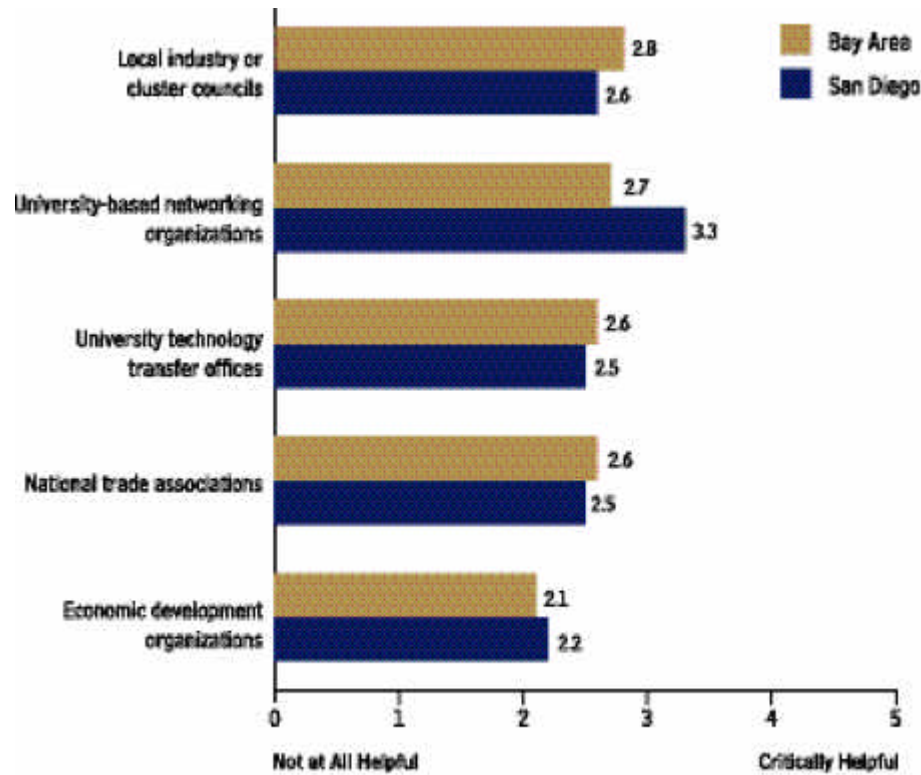
Over the next five years, what do you see as the most significant barriers to your firm's expansion within the local region?



Source: Bay Area Clusters of Innovation Quantitative Survey, 2002

Exhibit 43: Assistance for Entrepreneurs (Bay Area vs.San Diego)

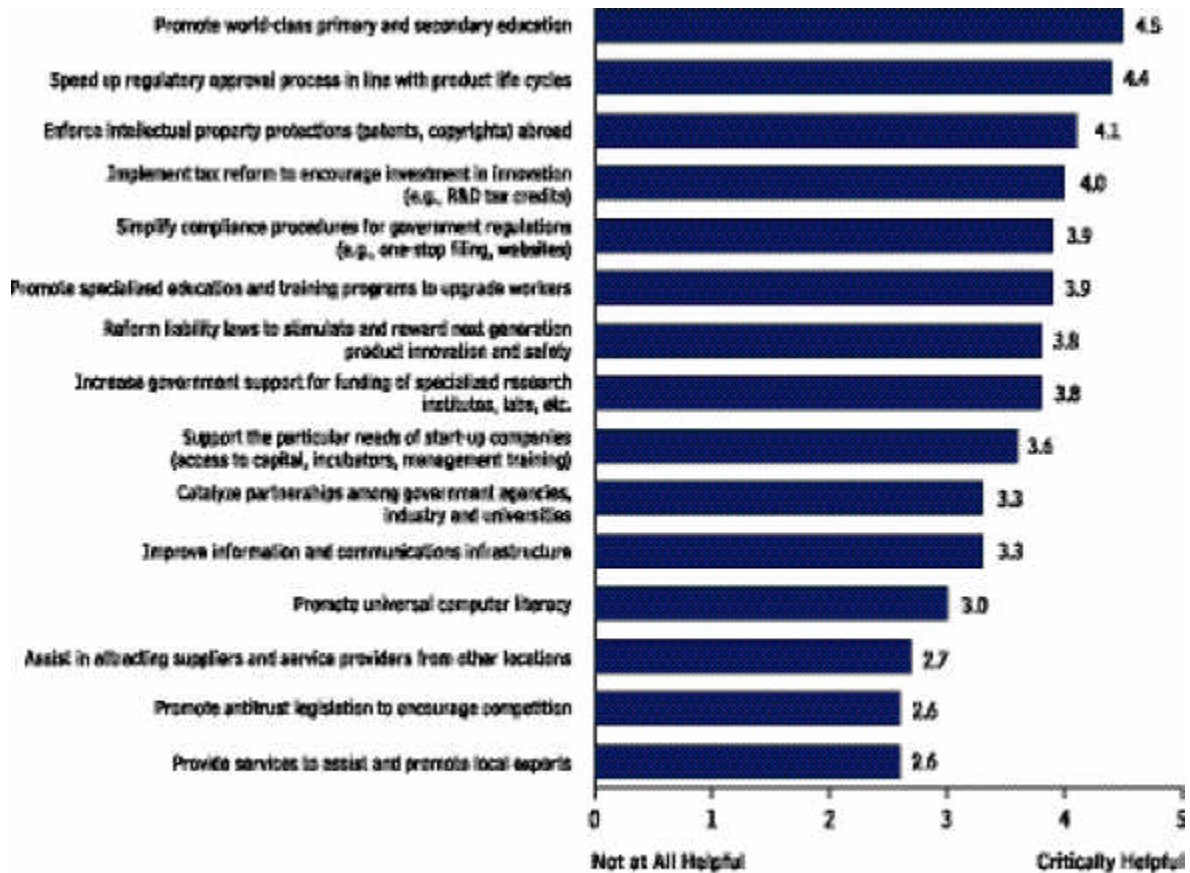
How much do the following institutions help entrepreneurs in your local region form valuable business contacts or obtain valuable business advice?



Source: Bay Area Clusters of Innovation Quantitative Survey, 2007

Exhibit 44: Priorities for Government

How important is each as a priority, for government over the next five years?



Source: Bay Area Clusters of Innovation Quantitative Survey, 2002

About THE STRATEGIC TEAM

The Monitor Group is a family of competitive service firms linked by shared ownership, management philosophy, and inter-related assets. Each entity in the Group is dedicated to providing products and services which fundamentally enhance the competitiveness of our clients. Our aspiration is to operate as an "intelligent switch" in a closely-linked global network of expertise and experience, not merely as a narrowly defined consulting firm, a research company or a merchant bank. We are dedicated to creating innovative, winning, action-oriented solutions by deploying our human, knowledge, and social assets in unique combinations dictated by each client's unique circumstances: consulting interventions, capital infusions, deal structuring, management development programs, customized software, cutting-edge market research, and so on as appropriate.

The Monitor Group is organized into three major operating units:

- Monitor Action Group, which consults to top management to help resolve their most important and intractable competitive problems;
- The Monitor Merchant Banking Group, which marries capital investment with advisory services to enhance company competitiveness;
- The Intelligent Products Group, which provides customized data and software products to support competitive decision making.

Monitor Regional Economic Competitiveness Team

Monitor's Regional Economic Competitiveness team focuses on developing action-oriented strategies tailored to the specific needs and capabilities of the nations, regions, and clusters we serve. The team has created an array of methodologies, unique data sources, and domains of expertise and experience that enable us to: conduct rigorous economic and cluster analysis of regions / clusters and their competitors; develop appropriate and actionable strategies for improving competitiveness; and assemble the broad-based coalition necessary for successfully affecting change.

Endnotes

- ¹ The Bay Area referred to throughout this Strategic Action Plan includes the nine California counties of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma.
- ² California Employment Development Department, 2001
- ³ “MassBio 2010 Report”
- ⁴ California Department of Finance
- ⁵ The Milken Institute (Economy.com)
- ⁶ California Employment Development Department, 2001
- ⁷ California Employment Development Department, 2001; U.S.Department of Labor
- ⁸ National Science Foundation
- ⁹ U.S. Patent and Trademark Office
- ¹⁰ PricewaterhouseCoopers
- ¹¹ “Signs of Life” Brookings Institute
- ¹² Life Sciences growth rate is based on the Bureau of Economy Analysis, Economy.com nominal 2002 - 2012 GDP forecast of four Life Sciences-related SIC codes (Pharmaceuticals (SIC 283), Measuring and controlling devices (SIC 382), Medical instruments and supplies (SIC 384) and Research and testing (SIC 873)), some of which contain non-Life Sciences companies; Bay Area nominal GDP projections based on Bureau of Economy Analysis, Economy.com 2002-2012 forecasts of San Francisco CMSA which includes Santa Cruz in addition to the 9 counties forming the subject of this strategic plan.
- ¹³ California Employment Development Department, 2001
- ¹⁴ 5.6% was the compound annual growth rate of the Life Sciences cluster from 1997-2001, based on figures provided in the 2002 Index of the Massachusetts Innovation Economy
- ¹⁵ The aggregate wage figure was calculated using the average regional wage of \$58,824 cited above.
- ¹⁶ Pharmaceutical and Research Manufacturers of America
- ¹⁷ Pharmaceutical and Research Manufacturers of America
- ¹⁸ Biotechnology Industry Organization
- ¹⁹ Global Business Network, “BioFutures”, 2002
- ²⁰ Ernst & Young “Beyond Borders Global Biotechnology Report”

- 21 Global Business Network, “BioFutures,” 2002
- 22 Silicon Valley / San Jose Business Journal, December 20, 2002
- 23 East Bay Business Times, August 30, 2002
- 24 Real Estate Journal.com, “Bay Area Development Reels From Recession,” January 2, 2002
- 25 Julie Brink, Director of Intellectual Property and Administrative Services, Gorilla Genomics; Oakland Tribune, “Biotech Incubators Find Warm Hosts,” October 21, 2002
- 26 Daniel Pollak, “California’s Bioscience Industries: Overview and Policy Issues,” October 2002
- 27 San Francisco Business Times, “East Bay Biotech Incubators Heat Up,” March 31, 2000
- 28 Bay Area Council, “Little Hoover Commission,” Outline of Testimony by Sunne Wright McPeak, June 28, 2001
- 29 Smart Growth Strategy—Regional Livability Footprint, Shaping the Future of the Nine-County Bay Area, October, 2002
- 30 Bay Area Council, “Programs and Policy Initiatives: Housing and Land Use”
- 31 Silicon Valley Manufacturing Group, “Projections 2002: Silicon Valley”
- 32 Silicon Valley Manufacturing Group, “Projections 2002: Silicon Valley”
- 33 U.S. Census 2000 Supplementary Survey
- 34 San Francisco Bay Area Water Transit Authority (WTA), *A Strategy to Reduce Traffic Congestion and Improve Air Quality – Draft Implementation & Operations Plan*
- 35 Keith Kennedy, San Francisco Business Times, “Bay Area’s Information Technology Expertise Doesn’t Extend to Transportation,” May 10, 2002
- 36 Arbitron
- 37 SiliconValley.com, “Bay Area Embraces High-Speed Net Access, Poll Finds,” December 9, 2002
- 38 A. Stephen Dahms, *The U.S. biotechnology industry: importance of workforce quality in the maintenance of corporate competitive advantage. Biochem. Mol. Bio. Educ.* 29, 206-208, 2001
- 39 *Biomedicine: The New Pillar of Northern California’s Economy*, 2002
- 40 Massachusetts Biotechnology Council, “MassBio 2010 Report”
- 41 *Signs of Life: The Growth of Biotechnology Centers in the U.S.* Brookings Institute
- 42 *Current Visa Restrictions Interfere with U.S. Science and Engineering Contributions to Important National Needs*, December, 2002
- 43 “Alumnus of Genentech, Chiron, Cetus Make Bay Area the Capital of Biotech Industry,” San Francisco Chronicle, April 2, 2001
- 44 California Technology, Trade, and Commerce Agency
- 45 Stanford Center for Entrepreneurship Studies
- 46 Industry and Higher Education, “Collaboration and Innovation: The State of American Regions” February 2002
- 47 BayBioNEST
- 48 National Science Foundation
- 49 National Institute of Health

- ⁵⁰ University of California Industry-University Cooperative Research Program
- ⁵¹ QB3 website
- ⁵² CITRIS website
- ⁵³ California NanoSystems Institute website
- ⁵⁴ California Department of Parks and Recreation
- ⁵⁵ U.S. Census Bureau
- ⁵⁶ Bay Area Council *Bay Area Poll*, May 2001, 2002
- ⁵⁷ Bay Area Council *Bay Area Poll*, May 2001, 2002
- ⁵⁸ California Joint Committee to Develop a Master Plan for Education, “California Master Plan for Education - Kindergarten through University: Professional Personnel Development Working Group Final Report,” 2002
- ⁵⁹ Richard M. Ingersoll, University of Pennsylvania, “Teacher Turnover, Teacher Shortages, and the Organization of Schools,” January, 2001



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